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The Unit of Heat

A CONTRIBUTOR to our correspondence columns rises to the support of the British thermal unit. Mr. Kent has said that it is one one-hundred eightieth of the heat required to raise a pound of water from 32 to 212 degrees and that is as definite as an inch or anything.

Professor Peabody says that it is the amount of heat required to raise a pound of water from 62 to 63 degrees Fahrenheit. Many authorities have defined it as the amount of heat necessary to increase the temperature of a pound of water one degree at its point of maximum density, 39 F.; and there are others.

The point in question, however, was not so much the establishment of a value for the British thermal unit as the finding of a *name* for it.

Suppose that every time we wanted to give the price of a thing we should have to say so many "U. S. units of value" as we would if we did not have the *dollar* as a name for it.

Suppose that every time we wanted to give a dimension we had to say so many "British length units," as we would have to if we did not have the specific names *inch*, *foot*, etc.

One one-hundred and eightieth of the amount of heat required to raise a pound of water from 32 to 212 degrees is by quite common acceptance, the British unit of heat quantity, but we need a *name* for it.

Heat is a form of energy. The c.g.s. unity of energy is the erg. The Joule is 10,000,000 ergs. One kilowatt is 1,000 Joules per second. Then a kilowatt-second = 1,000 Joules.

Why not take the kilowatt-second or the kilo-joule as the unit of heat quantity? It is equivalent to 0.948 of the B.t.u. as above defined.

The "mechanical equivalent of heat" would then be 738 ft.-lb. per kilo-joule instead of 778 ft.-lb. per B.t.u., the kilowatt-hour would be 3,600 of the new heat units instead of 3,413 B.t.u., and the horsepower-hour, 2,684 kilowatt-seconds instead of 2,545 B.t.u.

But why hang on to the horsepower when we have the kilowatt as a more scientific measure of the same thing?

F. R. Low

Fundamentals of Safety-Valve Design

By R. J. S. PIGOTT
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CERTAIN basic principles apply to all types of safety valves. These are clearly explained and illustrated by their application to the design of a high-lift valve

SINCE 1915 boiler pressures have increased from 250 lb. per square inch up to 400 lb. in many plants, 600 lb. in a few plants and 1,200 to 1,500 lb. in two plants. Temperatures (much more important than pressure) have increased in the same time from 550 or 600 deg. F. to 750 deg., which is about the practicable limit for steam-station service, since the strength and durability of all commercial materials fall off rapidly above this point. In oil-refinery processes pressures of 1,200 lb. and temperatures of 1,000 deg. now require equipment to stand these extreme conditions.

Since very little has been published on the design and functioning of safety valves, it has occurred to the writer that his experiences in developing a safety valve for extreme conditions may be of use to engineers interested in such equipment.

Requirements for Satisfactory Designs of Safety Valves

High capacity is one of the principal essentials, since it reduces the number or size of valves required, and also the cost per thousand pounds of steam relieved. Spring size is also reduced, and this point is becoming rather important for the higher pressures. Tightness is the next requirement, and presents a difficult problem, being much harder to obtain in a safety valve than in any other kind of valve. A globe or gate-valve disk may be screwed down, forcing the disk and seat to conform to each other if there is distortion, but at or near the popping point a safety valve has practically no pressure between seat and disk. Therefore, distortion must be completely eliminated if the valve is to be tight. Distortion of seats has usually been caused by temperature and pressure distortion, piping strains or body-casting strains. The common practice of screwing a short seat into the body furnishes a ready path for communication of body distortion to seat.

The shape and width of the seating surfaces have also a considerable effect upon "warn," the preliminary simmer that occurs just before the valve pops. Warn has the same effect upon seat and disk as a bad leak and, therefore, must be eliminated if possible.

Blowdown, the difference between the popping pressure and the pressure at which the valve will close, has hitherto been one of the limiting factors on high capacity—the smaller the blowdown the less the capacity.

For some years blowdown has been limited to 4 per cent of set pressure, and most designs attempt to keep it below this amount, down to 2 per cent as a minimum. Further reduction of blowdown is possible, but makes the safety valve very sensitive.

Durability, aside from the mere strength of parts, is principally a function of seating materials. We

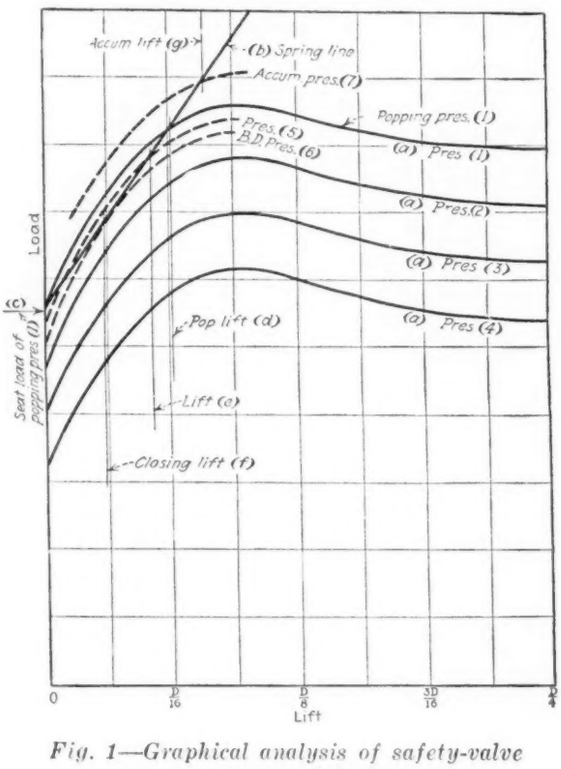


Fig. 1—Graphical analysis of safety-valve operation by load-lift diagrams

are dealing with steam velocities at the seat of 1,400 to 1,480 ft. per sec. (the critical velocity), and at the higher pressures the erosive power of a leak is enormous.

Corrosion is not of much importance, inasmuch as the bronzes are out of the question above 500 deg., and the high-temperature seating materials, such as Monel, Everbrite, the chrome-irons and the high chrome-nickel steels, all have satisfactory resistance to corrosion from boiler waters.

Maintenance is reduced by fewer valves, inherent tightness and, finally, by simple reseating processes.

Means for Obtaining a Nearer Approach to the Ideal Valve

The maximum capacity of a valve would be obtained if the seat were a perfect nozzle and the lift of the disk were one-fourth the nozzle diameter or greater. The first is easily obtained by forming in the valve a fair approach to the throat or seat and eliminating bottom guides on the disk. Bottom guides have been almost universally used, and where the lifts have been from $\frac{D}{32}$ (low lift) to $\frac{D}{9}$ (high lift), they have not been detrimental, as the velocity below the seat did not exceed 600 ft. per sec. But where the velocity is 1,400 ft. per sec., obstructions in the throat spoil the nozzle efficiency and cause cutting of the seat and disk.

If the pressure accumulates after the pop to pressure 7, the disk crawls up to lift *g*, increasing the capacity. But as the accumulation is limited to 6 per cent by the Boiler Code, the increase of capacity is also limited, and the lift is nowhere near $\frac{D}{4}$.

If the pressure decreases a little to pressure 5, the disk will crawl down to lift *e*. If the pressure is further decreased to pressure 6 (blowdown pressure), whose load-lift curve is tangent to the spring line, the disk will come to lift *f*, and since the load-lift line is then *less* than the spring load line down to seating, the valve will snap shut. Load-lift lines 2, 3 and 4 at lower pressures show that the shape of the curve is independent of pressure.

All the valves tested produced the additional lifting effort after popping by the "huddling chamber." That is, a restricted orifice, which can be altered by various

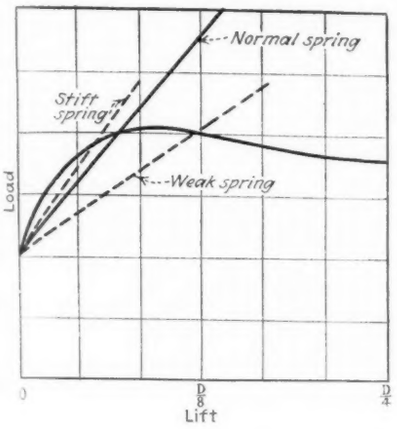


Fig. 2—Weaker spring increases lift and capacity, but greatly increases blowdown

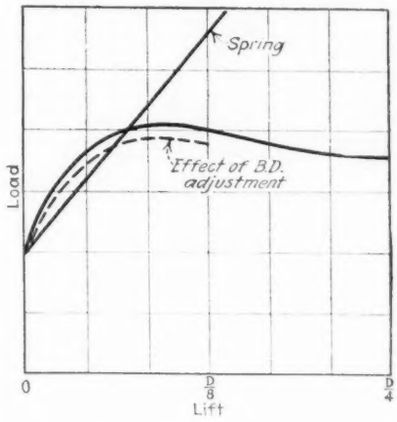


Fig. 3—Adjustment for less blowdown lays the curve over, reducing the lift

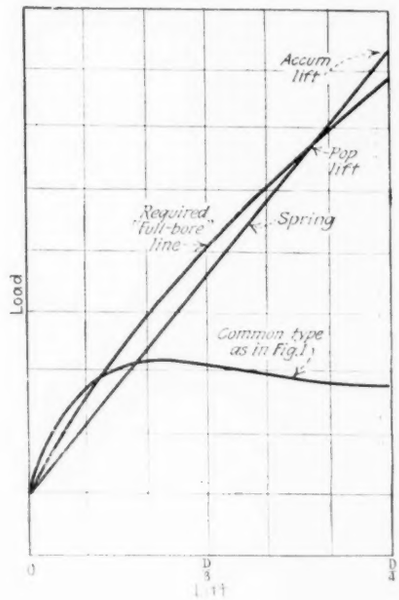


Fig. 4—(right)—Comparison of lifts with ordinary load-lift line and with "full-bore" line

To discover means for getting a lift of $\frac{D}{4}$ it was necessary to find how the lifting effort of various safety valves was produced. If lift is plotted against load, as in Fig. 1, the characteristics of the design may be determined by test. An experimental load-weighing apparatus was built, consisting of a suitable weighing-lever system applied to the spindle of a safety valve (spring removed), and a micrometer for measuring the lift. Several types of valve were then tested, and all gave load-lift curves of about the same shape as those in Fig. 1.

These experiments proved that all safety valves have a characteristic load-lift curve whose general shape is independent of pressure. They have also proved that valves based on static loading methods could not be made to reach $\frac{D}{4}$ lifts with limited accumulation of pressure or blowdown.

In order to develop a pop, the load-lift line *a* in Fig. 1, must exceed the spring-load line *b* up to some lift *d* at which it crosses the spring line. Since the two loads are there in equilibrium, the disk will come to rest at this point—the pop lift.

means, is provided between an extension of the disk and seat, beyond the seating surfaces proper.

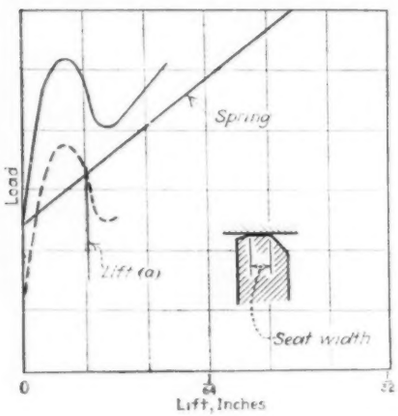
Before popping, only the seat diameter of the disk is subject to boiler pressure and determines the seating load. As the valve opens, however, the chamber between the seat and the restricting orifice is filled with steam, which builds up a static pressure on the extension to the disk, increasing the lifting effort instantaneously, providing the pop.

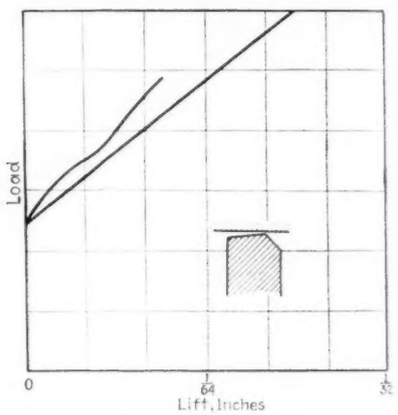
None of these valves made any material use of impact effects, the lifts being produced almost entirely by static pressures. From the falling away of the load-lift lines as the lift increased, there was no feasible way of getting a $\frac{D}{4}$ lift by static means only, although one make of valve actually did reach $\frac{D}{8}$ without excessive blowdown or accumulation.

Fig. 2 shows what could be done by changing springs. A light spring would give greater lift, and consequently greater capacity, but the hump in the curve would give excessive blowdown. A stiffer spring shortens the blowdown, but decreases the lift. Fig. 3 shows that adjustment for less blowdown lays the curve over so that the lift is also reduced.

Fig. 4 shows what is required to get the ideal valve —a long flat curve keeping close to the spring-load line, crossing it at not less than $\frac{D}{6}$ lift, so that with 3 per cent accumulation at the most, the curve would cross at $\frac{D}{4}$ lift. Analysis showed that if the full critical velocity were developed in the throat and the stream turned through 180 deg., there would be plenty of lifting effort at $\frac{D}{4}$ lift to sustain the disk, but there would be a considerable hump in the curve that would give a long blowdown.

The solution was found in a novel idea of G. S. Coffin, at that time mechanical engineer of the Crosby Steam Gage & Valve Co., and consisted of an outer ring, placed approximately level with the seat, and also serving as a guide for the disk. As the disk lies on the seat, the outer ring is not exposed to flow, and the first portion of the lift is obtained by the static pressure between the disk and the blowdown ring, together with a slight amount of reaction due to a small lip at the outer edge of the disk.





Figs. 5 and 6—Effect of seat width upon lower portion of load-lift curve and the warning lift (exaggerated diagrams)

Fig. 5 (left)—Effect of wide seat.
Fig. 6 (right)—Effect of narrow seat.

Model Valve Develops Three Pops

In the model that was built, the valve developed three different pops. The first was the lift with the disk and seat behaving like an ordinary static load-lift design. The second was after a slight accumulation, when the disk exposed the guide ring, and the reversal of the main stream occurred, raising the disk up to about $\frac{3}{16}D$. The third pop occurred with still further accumulation when the disk reached a little less than $\frac{D}{4}$ lift, and was due to the throat of the nozzle becoming the controlling orifice, which increases the impact effect.

The three pops are not necessary, as it has been proved (see Report of A.S.M.E. Research Committee) that no shock occurs to the boiler with any high-capacity valve, so the first pop was suppressed by adjusting the height of the guide ring and making some slight changes in contour of the seat. The valve opens to about three-fourths the full lift on the pop, and takes the last jump on a slight accumulation. The valve showed 97 to 98 per cent of the capacity of the nozzle blowing free, indicating that the capacity was the maximum that can be reached.

The question of seat durability was next studied. It was evident, from experience with older valves, that the high-nickel alloys were far from satisfactory. Tests were undertaken by K. S. M. Davidson on a variety of materials.

Safety-valve seats and disks were made up to standard dimensions, of cast bronze, Monel, tin-hardened Monel and Nicoloy, forged Everbrite and a forged high-chrome-nickel steel. The Nicoloy and Everbrite contain about 30 per cent nickel. Parts were mounted in a valve body and clamped at a lift of 0.005 in. Steam was then blown through at 250 lb. for 300 hours each. The bronze, naturally, was the worst, the chrome-nickel alloy by far the best. Further tests were carried on, and showed conclusively that a good seating material for high temperature and pressure must have high Brinell hardness and fine grain.

Chrome-Nickel Steel Adopted

The best material, a forged chrome-nickel steel, resisting corrosion in the unheat-treated state, was adopted for the valve.

With regard to warn, Figs. 5 and 6 illustrate the research results. The first seats used were about 0.05 in. wide and gave trouble from warning. Load-lift study showed the wide seat acted as a nozzle and produced a distinct hump in the lift curve, causing the disk to hang at about 0.005 lift. The valve would not pop until the pressure rose enough to bring the bottom of the loop in the curve above the spring line.

By modifying the seat to a very narrow surface, the load-lift curve was smoothed out and the warn disappeared. It was also found necessary to provide careful means to center the spindle, as eccentric loading of the disk will also produce warn. The best means was the use of a hard steel ball as a spindle point seated in a hardened steel cup with very small area of contact.

General Design of Valve

Fig. 7 is a cross-section which indicates the practical application of the research work to the shop product. The throat tube 1 is of forged high-chrome-nickel alloy steel. The screw thread is used only for assembling the valve and is not required to be steam-tight, as the joint is made by using the end of the throat tube against the boiler outlet. The long symmetrical nozzle frees the seat of any possibility of transmitted body distortion. The throat opening was standardized at 45 to 50 per cent of the inlet pipe area, in order to insure against inlet restriction, which is fatal to the satisfactory operation of any safety valve.

When tried with the throat opening the same size as the pipe inlet, mounted directly on the boiler out-

let, with a rounded approach, the valve functioned satisfactorily, but it would be a serious risk for the average installation, inasmuch as there is too much chance of the valve's being installed with a sharp-edged entry from the boiler shell, elbows or length of pipe between the boiler and the valve, in which case the high velocity would cause a serious reduction of pressure at the valve (chattering).

It is to be remembered that the outlet size of the body dimensions of the valve are determined by the

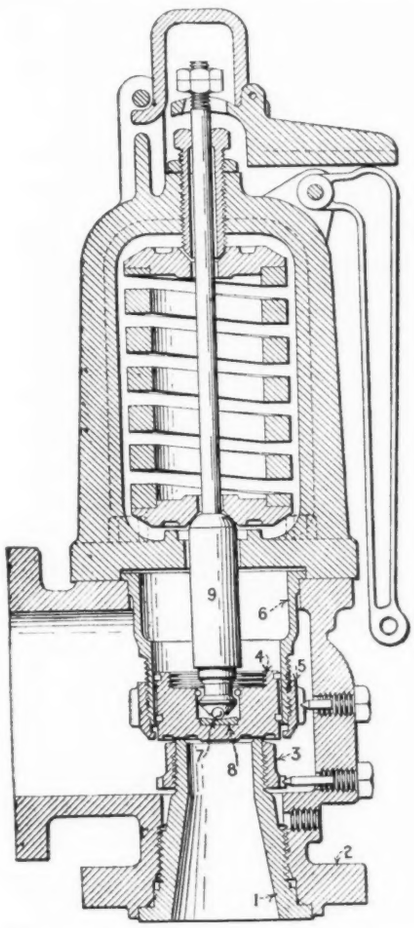


Fig. 7—Design of full-opening valve

capacity of the valve, since the discharge pressure is somewhere near atmospheric. It is not feasible to reduce the area of the outlet to a point where the flow will be greater than 5,500 lb. for each square inch of outlet area.

This form of valve will stand back pressures as high as 20 per cent of the initial pressure, without affecting the operation. This is because the back of the disk is protected from back pressure by the guide.

Blowdown adjustment does not affect the capacity of this valve, inasmuch as it has nothing to do with the maximum lift. In fact, although a blowdown ring (3 in Fig. 7) is used for high-pressure steam, the valves can be made without any breakdown adjustment whatever, blowdown being fixed by the contour of the seat.

It was found necessary to build the valve with the outlet three pipe sizes larger than the inlet, in order to obtain sufficient area for this very high capacity. Inasmuch as the seat area is only about 20 to 25 per cent of the seat area for a valve of ordinary lift, the spring loadings and stresses involved in the yoke are proportionately reduced.

For pressures higher than 600 lb. the capacity of such a valve would be enormous; a 3-in. valve would deliver over 200,000 lb. per hour at 1,500 lb. pressure. The spring size would, of course, increase very greatly, making the valve topheavy. Since there is no demand at present for such a capacity in a single valve, it was thought wiser to reduce the size of the throat opening and disk, keeping the same size body and yoke and about the same size spring, which gives a better general layout.

As an indication of the attainment of the ideal curve predicated in Fig. 4, a load-lift test curve is shown in Fig. 8.

It seems to the writer that the foregoing research work was interesting in that the whole of the program for the design of the new valve was predicated upon calculation rather than by the cut-and-try method, which, unfortunately, has been the commonplace in valve design.

The outstanding results of the research have been the method of analysis, which completely defines the safety valve, and the discovery that high Brinell hardness and

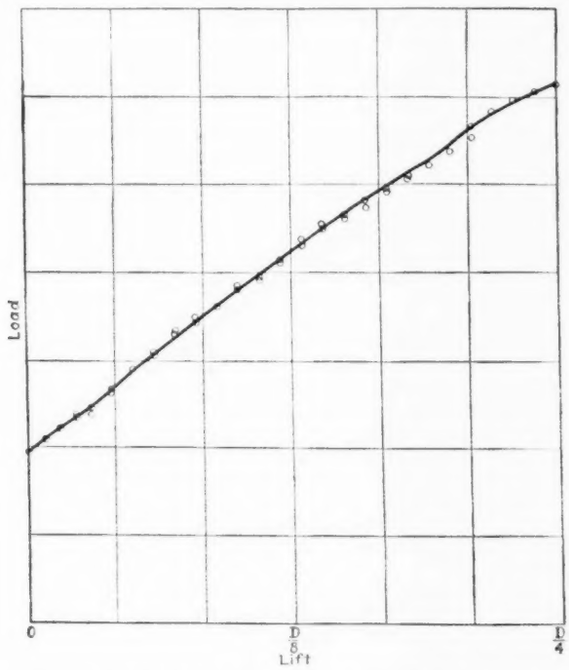


Fig. 8—Actual steam load line from full-opening valve

close texture of grain are the two principal requirements for resistance to erosion in seating materials.

The research work described herein was carried out at the laboratory of the Crosby Steam Gage & Valve Co., of Boston, Massachusetts.

A CORRECTION—In the refrigerating article by A. T Nicholas, which appeared in *Power*, March 8, in reference to Fig. 2 the statement is made that "from *B* to *C* the vapor is dry saturated." This is erroneous and is due to an alteration in the lettering. The statement should read: "From *C* to the point P_2, slightly above it, the vapor is dry saturated. This condition is along the dry saturated line and represents the flow of the vapor from the cooler to the suction side of the compressor."

Surface Condenser Heat Transfer

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THERE is still much discussion in current technical literature concerning the coefficient of heat transfer in the design of steam surface condensers. The author attempts to correlate the principal factors on this subject and proposes some solutions which include several ideas that are new and perhaps a bit radical.

THE steam surface condenser's function is to condense the exhaust steam from a steam engine or steam turbine. Condensation of the exhaust steam reduces the back pressure on the prime mover so that more work can be done per pound of steam passing

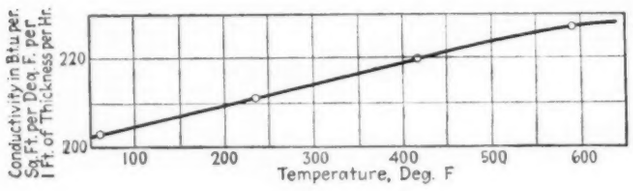


Fig. 1—Conductivity of copper

through the prime mover. The result, therefore, of using the condenser is to get more work out of the steam per pound supplied.

Condensation of the steam is obtained in the surface condenser by using cold circulating water, which is forced through metal tubes on the outside surface of which the steam condenses by transmitting its latent heat to the water circulating within the tubes.

This is a simple enough process and presents no great difficulties in small units, but for large units it pays to consider carefully the amount of cooling surface required, the total size and weight of the condenser and its "live load" of circulating water, and the power required to circulate the cooling water. By a "large unit" we mean anything of 10,000 kw. capacity or larger.

In large units a saving of 1,000 sq.ft. of cooling surface represents a saving in first cost ranging from $600 for the tubes alone up to $3,000 if the shell size is affected.

Four Factors To Be Considered

In order to design a condenser efficiently, one must consider many factors, but the author wishes to emphasize especially the requirements to meet satisfactorily four factors only:

1. Condensation of most of the steam.
2. Cooling of the air.
3. Cooling of the condensate.
4. Final devaporization of the remaining steam.

Hausbrand[1] divides condensation into *two* periods and says: "The mean temperature difference between vapor and cooling water (first period) decreases with the increase in temperature of the waste water, but it is very little affected by the extent to which the condensed liquid is cooled. In the latter respect the difference may be neglected in practice.

"The mean temperature difference between the condensed liquid and the cooling water (second period) is considerably affected by the extent to which the final temperature of the condensed liquid is to approach that of the cooling water, but it does not depend to any great degree on the *temperature* of the waste water. In the latter respect the variations may be disregarded, and the mean temperature difference for the second period may be taken for all cases as the mean temperature difference calculated for waste-water temperature of 68 to 176 deg. F., without regard to the actual temperature of the waste water in the particular case."

Proper Design Important

If the condenser be designed properly, the cooling or heating of the condensate may be considered in the calculations, but will not amount to much. By "proper" design we mean having graduated or differential tube spacing with *straight* rows of tubes so that there is unrestricted steam and air flow throughout the tube bank. The staggered tube arrangement and the minimum commercial pitch both interfere with free steam and air flow.

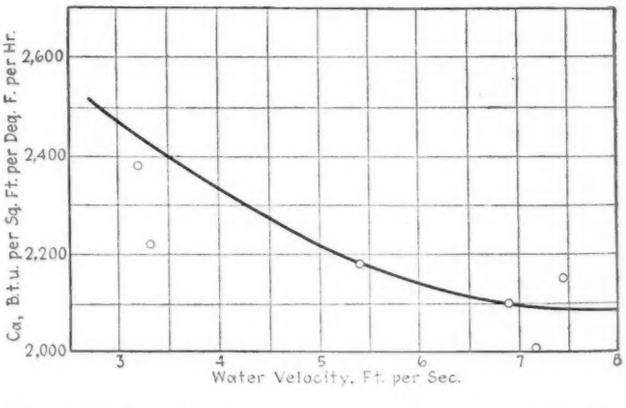


Fig. 2—Rate of heat transfer from steam to brass pipe

The cooling surface required for a given condenser can be divided into four parts. First, the largest portion needed to condense about 99 per cent of the steam. A drop of 1 deg. F. in temperature of the exhaust will condense about 99 per cent of it. If the designer wants a more accurate figure, he can get it by calculating from the steam and air partial pressures which apply to his particular case. Second, we have the surface required to cool the small amount of air present. Even with 10 deg. of cooling this is generally a negligible amount.

[1] "Evaporating, Condensing, and Cooling Apparatus," revised English edition, 1915, p. 87.

Third, the cooling of the condensate, which should be about 3 deg. F. Fourth, the devaporization of the remaining 1 per cent of the steam, which requires 10 deg. F. of cooling or even more. This also may be more accurately calculated if necessary by assuming steam and air partial pressures. (See "Transactions of A.S.M.E.," 1915, pp. 897, Gibson & Bancel.)

Finding the Coefficient of Heat Transfer

The coefficient of heat transfer K for condensation of the steam may be obtained from recent test data. Some preliminary discussion is rather necessary, however. This coefficient may be split up into five parts, as pointed out by Arthur M. Greene, Jr., who says[2]:

"It appears from calculation that anything which would tend to decrease the thickness of the films of water or gas would cut down the drop of temperature in these, putting a greater drop in the wall and so causing an increase in the heat transmitted. One method of doing this is to increase the velocity of the substance bringing heat up to the surface or taking heat from the surface. This has been tried and found true. The increase of velocity of the gas or water wipes some of the film away, decreasing its thickness. This simple explanation is evident and shows why one would expect an increase in the heat transmitted, if either the velocity of the gas or the velocity of the water were increased across the surface transmitting the heat.

"It can be shown theoretically if we consider the rate of heat transmission to be affected by the air film on a tube, the cleanness of the outside of the tube, the conduction of the tube material, the cleanness of the inside of the tube and the water film inside the tube that

$$K = \frac{1}{\frac{l_a}{c_a} + \frac{l_c}{c_c} + \frac{l_b}{c_b} + \frac{l_{c_2}}{c_{c_2}} + \frac{l_w}{c_w}}$$

In which l in each case designates the thickness of the film or wall, in feet, and c the coefficient of heat conduction for the material, in B.t.u. per hour per square foot of area per foot of thickness per degree F. temperature difference. The subscripts designate the several layers, a the air film, c the dirt on the steam side

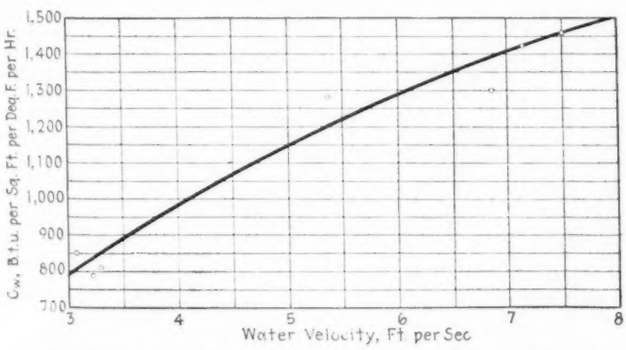


Fig. 3—Rate of heat transfer from brass pipe to circulating water

of the tube wall, b the tube wall itself, c_2 the scale on the water side of the tube wall, and w the water film.

"To apply this formula we must know the thickness l_a and l_w of the air and water films. These film thicknesses depend on the velocity of the respective media.

"The values of c_a and c_w depend on the temperatures of the air and the water and probably on their viscosities and the hydraulic radius of the pipe.

"The values of the c's for the solid materials will vary with the temperatures and thus K will depend on the temperature.

"*These values, however, can only be determined experimentally* whether they depend on velocity, temperature or anything else."

If we assume the tubes to be clean on both the inside and outside, we can drop out two of the five factors that determine K and the formula becomes

$$\frac{1}{K} = \frac{1}{C_a} + \frac{1}{C_b} + \frac{1}{C_w}$$

in which C_a is rate of heat transfer on the steam side

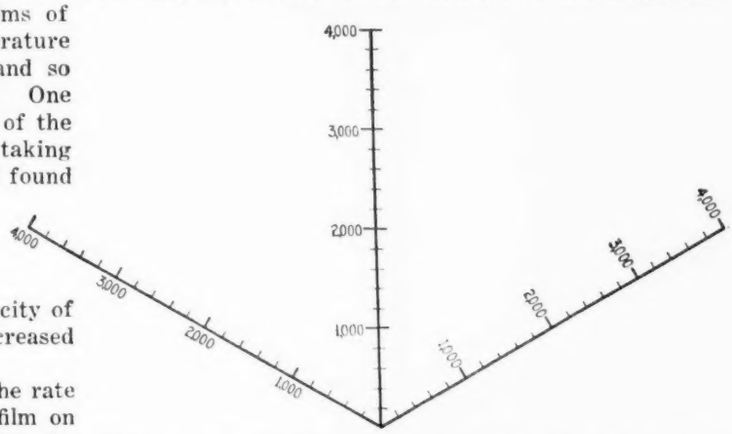


Fig. 4—Hexagonal chart for combining heat transfer coefficients

Any straight line drawn across the three scales will intersect them at points such that the number on the center scale is the reciprocal of the sum of the reciprocals of the two numbers on the outer scales. For example, a line intersecting the outer scales at 1,000 and 1,000 will cut the center scale at 500. This should be drawn larger for accurate work. It consists simply of three identical scales laid out with 60-deg. angles between them. The chart is a great time-saver.

of the tube through the air film to the tube, for the actual thickness, $= \frac{c_a}{l_a}$; C_b is the coefficient of conductivity of heat through the metal of the tube wall, for the actual thickness, $= \frac{c_b}{l_b}$; C_w is the rate of heat transfer from the inside of the tube through the surface film to the circulating water, $= \frac{c_w}{l_w}$.

Numerical Values

C_a is given by Bancel as about 4,000, C_b as "very large," and C_w as 200 to 1,000. This gives values of 800 to 190 for K_s if we omit the middle term for C_m, the metal conductivity.

C_a is given by J. E. Bell as 3,400, C_b as 49,700 for a 1-in. tube, and C_w becomes 1,877 with a circulating-water velocity of 2½ ft. per sec. This gives a value of 922 for K. At 3 ft. per sec. K is 1,210, while at 6 ft. per sec. the value becomes 1,433.

The curve of Fig. 1 shows that the conductivity of copper does not change appreciably throughout the temperature ranges which occur in a surface condenser. As the value of C_b is so great compared to C_a and C_w, it will affect K only in the neighborhood of 2 per cent at most. It can therefore be neglected, as the values of C_a and C_w are experimentally obtained within an accuracy of only about 10 per cent.

[2]"Heat Engineering," by Arthur M. Greene, Jr., McGraw-Hill Book Co., 1915, page 87.

The formula for K may then be reduced for practical purposes to

$$\frac{1}{K} = \frac{1}{C_a} + \frac{1}{C_w}$$

This formula is similar to the electrical formula for resistances in parallel, and a clever graphical solution of this type of formula known as the hexagonal chart has been developed. This is shown in Fig. 4 as applied to a solution for K.

The data for C_a and C_w to plot curves of Fig. 2 and Fig. 3 were obtained from experimental data published by Professors MacAdams and Frost, of the Massachusetts Institute of Technology, in the *Journal of Industrial and Engineering Chemistry*, January, 1922.

Using the Curves

The values of C_a and C_w from the curves, Fig. 2 and Fig. 3, corresponding to the same water velocity, may be used with Fig. 4 to determine values of K. This has been done by the author, and results are shown in the curve of Fig. 5 for K.

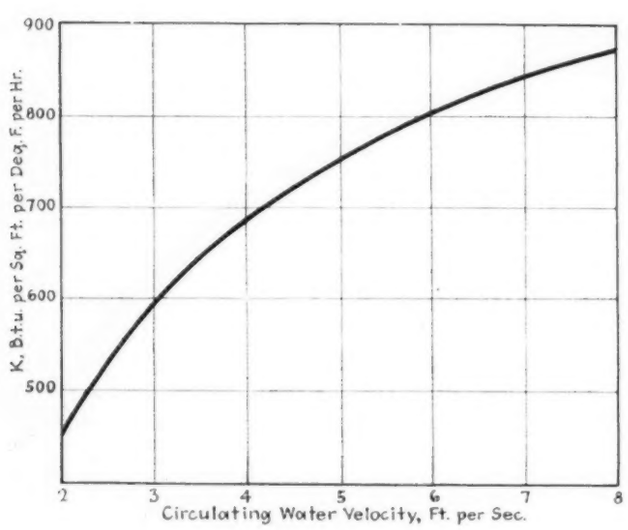


Fig. 5—Typical values for heat-transfer coefficient from steam to water

Values of K for predetermined circulating water velocities may be obtained from the curve of Fig. 5 with confidence that they are close to values to be obtained in practice. If the designer wants to allow more cooling surface to take care of dirty tubes, he may do so by using the usual cleanliness factor of 0.9, but a condenser is expected to be kept clean anyhow, and, in view of the cost of the additional surface and of the larger shell that is often required to accommodate it, a good case can be made for using only the calculated surface, especially since the maintenance of a clean condenser improves the plant economy.

For the other three factors—cooling of the air, cooling of the condensate and final devaporization of the steam—additional cooling surface will be needed. However, condensers have been built with air coolers that have a surface equal to 10 to 30 per cent of the total condenser surface; if the designer does not want to consider these items in the detail, therefore, he can add 25 per cent to the surface figured from the value of K as obtained from Fig. 5 and be certain that he has a condenser with ample cooling surface.

Cause and Prevention of Iron Rust

By Anthony J. Christopher

It is generally supposed that the oxygen of the air and water is the direct cause for the chemical action which forms rust or oxide of iron. Iron will not rust in pure dry oxygen, nor in the presence of air or water if they do not contain carbon dioxide and the same water remains in contact with the metal continuously. Oxygen combined with other elements hastens the rusting process. Moisture, carbon dioxide and gaseous sulphur compounds produced by the burning of soft coal contribute to the corrosion of iron.

Acid vapors promote rusting, and carbon dioxide with water vapor, both constituents of the air, form carbonic acid. Under ordinary conditions carbonic acid is an initial cause of the oxidizing of iron. Three principal chemical changes take place from the time the water vapor and carbon dioxide first act upon the iron in the form of carbonic acid to the stage of iron oxide, and traces of all three changes always exist in any rusting process. Chemically, the union of carbonic acid and iron forms iron carbonate and a gas. This carbonate with the addition of water and oxygen in the air changes to iron hydroxide and carbonic acid. The latter is then free to start anew its elementary work of rusting, while the iron hydroxide changes to water and metallic oxide or iron rust.

The rusting of iron proceeds rapidly when once started. The reason for this is that rust is its own catalytic agent; an amount of rust helps to produce more rust. This fact is made clear by placing a pinch of rust on a shiny piece of iron. In a few days the rust may be brushed away and the spot where it had rested will be pitted. In a tin can this action continues until nothing remains but the solder and brown oxide dust, while on a bar of iron the rust scale forms thicker and deeper. The catalytic action of iron rust is believed to be similar to the electrolytic process of a battery.

Iron, unlike most of the other common metals, does not provide for self-protection against corrosion. The formation of an oxide on the surface of lead, copper, aluminum, zinc, etc., protects the metal underneath the surface. The formation of ferric iron at ordinary temperatures aids in producing more rust. Hence it is necessary to prevent the formation of the natural oxide on iron by coating it with something else. A film of any easily oxidized substance such as linseed oil (paint), grease, carbon, lead or other metal may be used to ward off the formation of rust. When hot iron is treated with superheated steam and carbon dioxide, a deposit of magnetic oxide of iron forms on the surface and is very effective as a protective coating. It has been stated previously that carbon dioxide and water cause the metal to rust; but the same materials, under the influence of great heat, produce the magnetic oxide film. This principle of rustproofing is employed in several commercial processes, one of which is known as Parkerizing. Large parts of iron cannot be treated in this manner, and therein lies a handicap to the process.

Cement mixtures have been used as a paint for rustproofing purposes. Alkalies prevent rust, and as cement is alkaline, it has this advantageous feature. Cement is porous, which permits gases and water to diffuse through it and gradually attack the metal. Therefore, it is not a dependable rust preventive unless improved to eliminate the unfavorable characteristics.

The Successful Diesel Engineer Uses an Indicator

By R. C. SHOOK

Without an indicator the engineer just guesses. A diagram reveals any valve or cylinder defect. Indicators are easy to handle and are not costly

THE taking of indicator diagrams forms one of the routine duties on large internal-combustion engines, particularly oil-burning units. While most engineers realize that the diagram gives the whole story of what is taking place in the cylinder, the full advantage and helpfulness of the indicator in locating and eliminating difficulties encountered in operating is often not fully realized.

In fact, many engineers have a tendency to disregard the indicator except to determine the indicated horsepower, maximum pressure and note the general shape of the diagram. They have the appearance of the correct diagram fixed in their minds and can tell at a glance if ignition is early or late and can locate such trouble as dripping fuel valves, high injection pressure, clogged atomizers and incorrect timing. All these conditions are shown at the top of the diagram, and as the most important events of the cycle are shown there, it is quite natural that much of the information available to engineers deals with the analysis of conditions at this point. Therefore the operator is led to believe that if there is no deviation from the normal, his engine is working perfectly and no further investigation is necessary. This, however, is not always true.

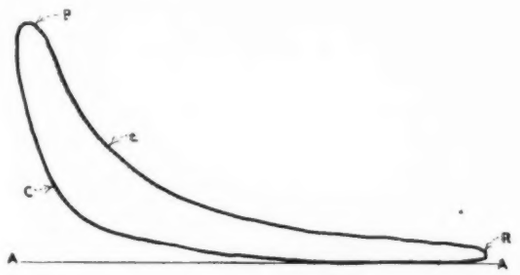


Fig. 1—A normal Diesel indicator diagram from an air-injection engine

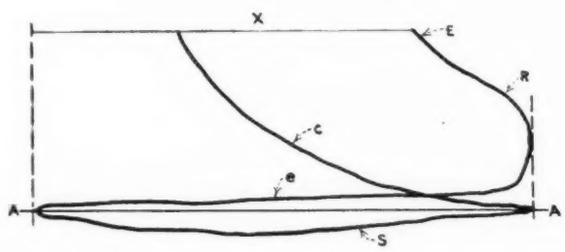


Fig. 2—Light-spring diagram shows excellent suction and exhaust conditions

Let us take for example Fig. 1, which shows a typical four-stroke-cycle diagram. The compression curve *C* is smooth and regular, ignition has taken place at the proper time, the combustion line *B* shows an approximation of the theoretical constant pressure, while no fault can be found in the expansion curve *E*. There appears to be nothing unusual with the release at *R*, and the exhaust and intake seem to lie on the atmospheric line *A*, all of which would indicate that the diagram is normal.

We are aware that, in the ideal cycle, suction and exhaust take place at atmospheric pressure, which would make these lines on the diagram coincide with the atmospheric line. This would further indicate that no trouble could be expected here in the engine from which this diagram was taken. Yet if we will stop to consider that this diagram has been taken with a spring giving one inch of height for 360 lb. pressure, we realize that a variation of five pounds pressure would mean a height of only 0.011 in., which would hardly be noticeable on a diagram, and that perhaps there is something that is not fully revealed in the single line indicating both suction and exhaust.

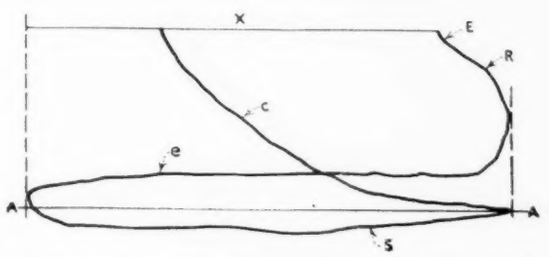


Fig. 3—The exhaust line is entirely too high, indicating a choked exhaust

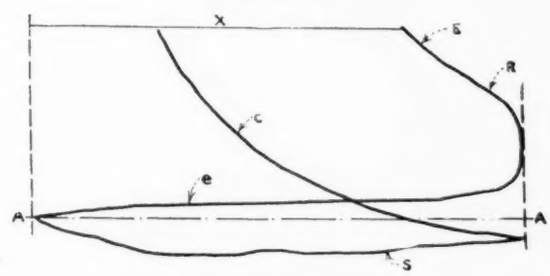


Fig. 4—The diagram shows an excessive suction pressure drop

The actual conditions might be as any of those shown in Figs. 2 to 4, which were taken with a light spring in order to show what is actually taking place at this part of the cycle. If a diagram similar to Fig. 2 is obtained, the engineer can be satisfied that all is well. Although the exhaust line *e* does not reach atmospheric pressure soon after release at *R* and the suction line *S* lies below the atmospheric line *AA*, the pressures at the end of the exhaust and intake strokes are almost atmospheric. It should be kept in mind that the theoretical ideal is sel-

dom reached in actual practice, as it is impossible for the designer to use valves, ports and passages that will not offer some restriction.

The diagram in Fig. 3, however, clearly shows that something is wrong, as the exhaust pressure indicated by line *e* is very high and does not drop to atmospheric until after the piston has started on the suction stroke. A condition such as this, probably due to a choked exhaust pipe or dirty silencer, gives a greater percentage of burnt gases in the mixture used in the next cycle, and necessitates more frequent overhaul of the exhaust valves, besides the loss in power due to the back pressure.

An intake pipe seemingly bright and clean from the outside, yet having the slots partly clogged with dirt and lint, will cause the diagram to be similar to Fig. 4. Here the exhaust line is close to the normal, but the suction line *S* shows a partial vacuum, more noticeable at the middle part of the card where the piston is traveling the fastest, but enough at the end of the stroke to give a lower compression pressure and to reduce the air available for combustion. Besides the conditions illustrated, faulty timing of the intake and exhaust valves, high and low scavenging pressures on two-stroke-cycle engines are only a few of the abnormal conditions which will be easily detected from a diagram giving these events on an enlarged scale. Unfortunately, most indicator manufacturers have merely made the old steam-engine indicator smaller, provided stiffer springs and call the product an indicator for internal-combustion engines.

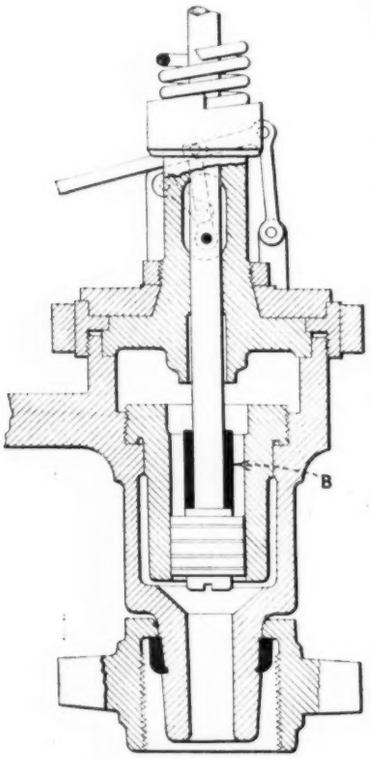


Fig. 5—Arranging an indicator for light-spring diagram

When taking light spring diagrams, 20- to 50-lb. springs are generally used, depending on whether only the exhaust and intake lines are to be shown or the release pressure is also desired. A pressure of more than 30 to 75 lb. should not be recorded with such springs, while a pressure of from 50 to 125 lb. may be enough to give the spring a permanent set; that is, strain the material of which the spring is made past its limit of elasticity, thus rendering it useless for future use. It will be noticed that the lines *C* and *E* on the light-spring diagrams show a very rapid rise, which would, if they were allowed to continue, soon run entirely off the indicator card, and as the maximum pressure during the cycle is about 500 lb., it is evident that a stop must be provided to limit the height of the diagram. Although the piston or shoulder on the piston rod coming up against the cylinder cover would prevent the pencil from running entirely off the card and eliminate chances of breaking the spring, the high maximum pressures would give a severe shock to the whole mechanism, whereas by using a stop that halts the piston when the pressures are only about 50 lb. per sq.in., this is avoided. The line *x* on the low-spring diagrams shown is due to the limiting of the diagram.

The only indicator thus equipped, with which I am familiar, has a very simple means of adjusting the limit of piston travel. When a light-spring diagram is to be taken, a stop nut is screwed down until the space between its bottom face and the top of the piston is such that the piston travel will be limited to the distance giving the diagram height desired.

For indicators without such an attachment a most inexpensive stop, shown in Fig. 5, can be made. It consists merely of a sleeve or bushing *B* placed on the piston rod between the cylinder cover and piston, thereby limiting the piston travel to the distance left between the sleeve and the cylinder cover.

Gas Expansion Curves Plotted by Nomogram

By C. Albert Kulmann

LABORIOUS computations are ordinarily necessary when plotting a curve for the expansion of a quantity of gas. These computations are particularly time-consuming if the value of the exponent n in the equation $pV^n = C$ be one and a fraction. If many points on the curve must be determined, the amount of work becomes too great to be worth while.

To make this labor unnecessary, the writer has designed the chart shown on the facing page. With this as many points may be plotted as desired in a small fraction of the time otherwise necessary and with an accuracy that will probably equal that of the scale on which the curve is plotted.

The use of the chart is simple. On the right is a graph on which is found a point representing V^n. This point lies at the intersection of the vertical line for the value of n used and the horizontal line corresponding to the volume at the start of expansion. A straight-edge passing through this point and the corresponding initial pressure on the left-hand scale will intersect the dummy scale at some arbitrary graduation corresponding to the value of C. The actual graduations on the dummy scale have no significance except as they make it easy to note the intersection of the straight-edge.

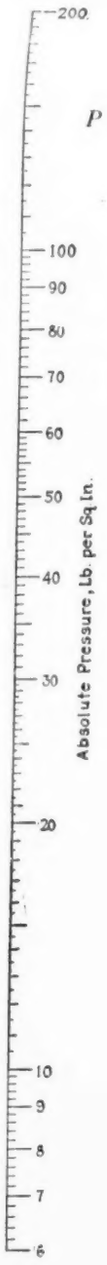
By pivoting the straight-edge about this point on the dummy scale and changing the value of either P or V, the new value of V or P may be read off directly. The value of n cannot, of course, be changed until a new problem is started.

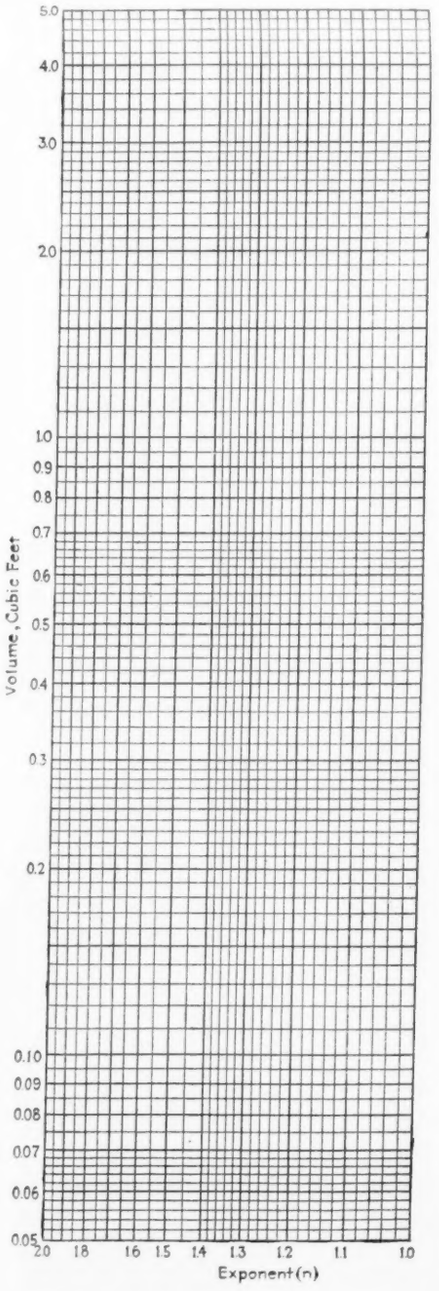
An example will make the method of operation more clear. Suppose that a given mass of air has an initial pressure of 70 lb. absolute and an initial volume of 0.11 cu.ft. Assume this air to expand according to the law $PV^{1.4} = C$. A straight-edge laid from 70 lb. on the left scale to the point on the right graph where 0.11 cu.ft. intersect the $n = 1.4$ line, cuts the dummy scale at 6.22. Holding this point and swinging the straight-edge to various values of pressure, the following corresponding volumes are read on the line for $n = 1.4$; $P = 70$, $V = 0.11$; $P = 50$, $V = 0.140$; $P = 30$, $V = 0.203$, etc.

Nomogram for Gas Expansion Equation $PV^n = C$

P = Absolute Pressure V = Volume n = Exponent C = Constant

By C. Albert Kulmann





Instructions—Use straight-edge to connect initial pressure on left-hand scale with point on right-hand graph where horizontal line for initial volume crosses vertical line for expansion coefficient n. Take intersection of straight-edge with dummy scale as pivot for all further movements of straight-edge in plotting the given expansion curve. Other corresponding values of P and V are read respectively on the left scale and on the right vertical line corresponding to the value of n.

Veterans Still on the Job

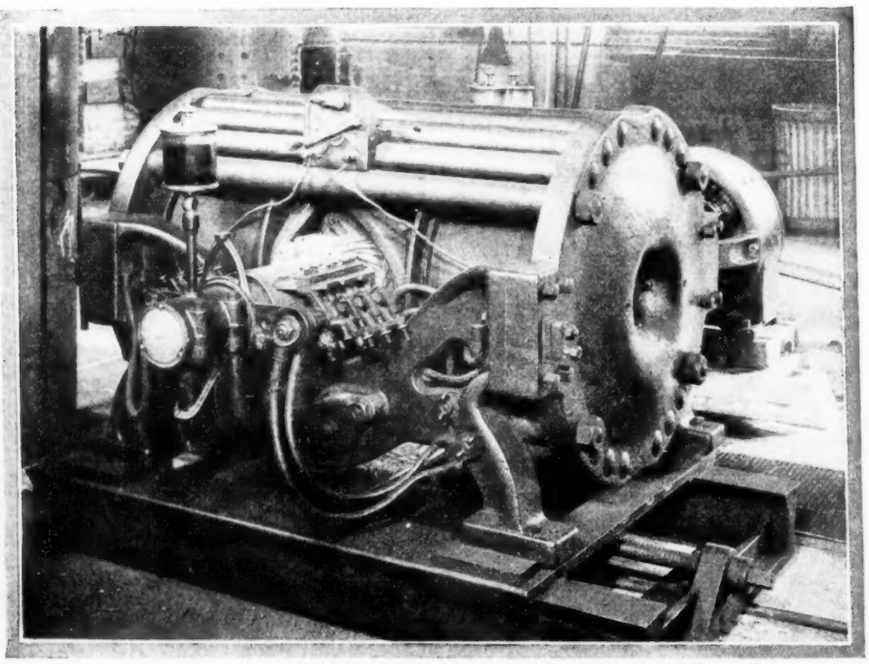


Photo by courtesy of General Electric Company

Above—About forty years ago this Thomson dynamo started lighting 400 sixteen-candlepower lamps on the streets of Washington, D. C. It is still used for testing in the George Washington University Laboratory

Below—These old Brush arc machines have been working for the Buffalo General Electric Company for 27 years straight. But Walter Elliott, at the right, beats this with a record of 36 years

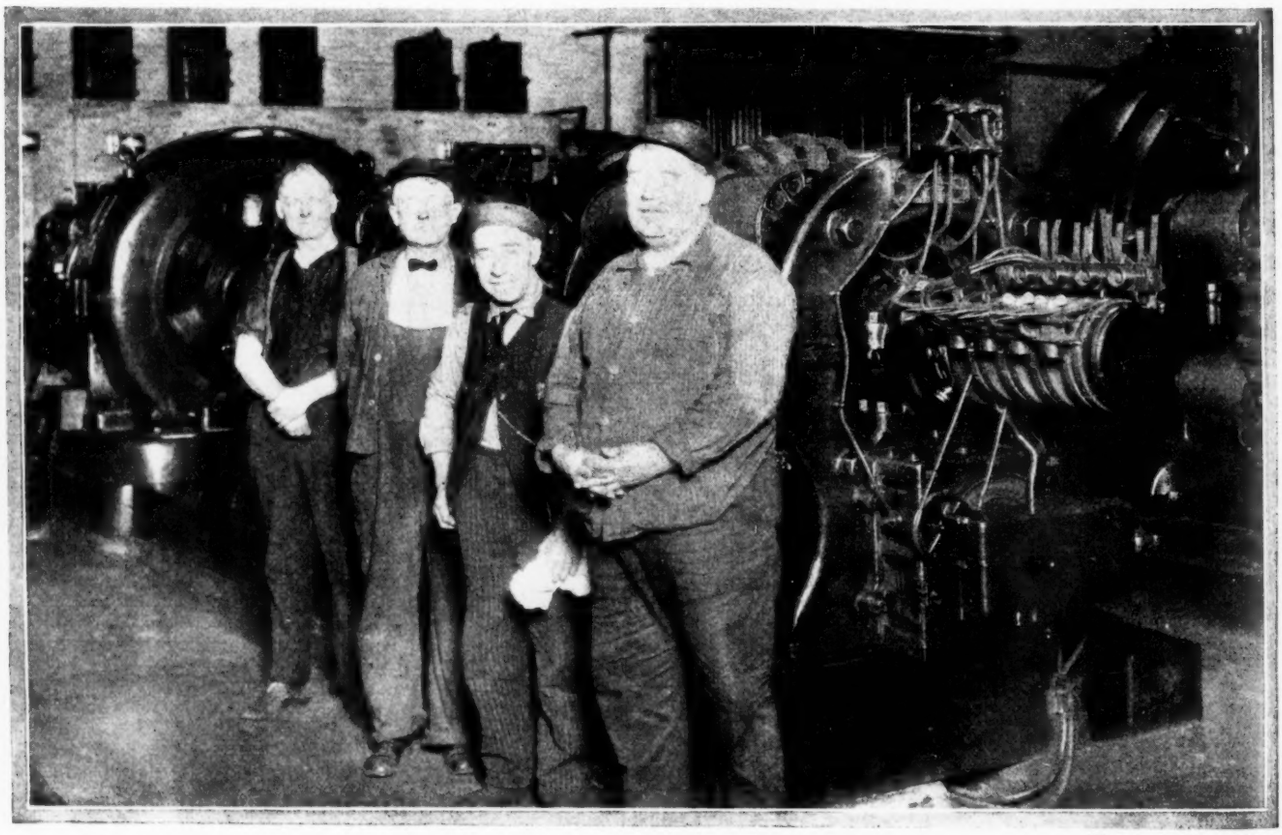
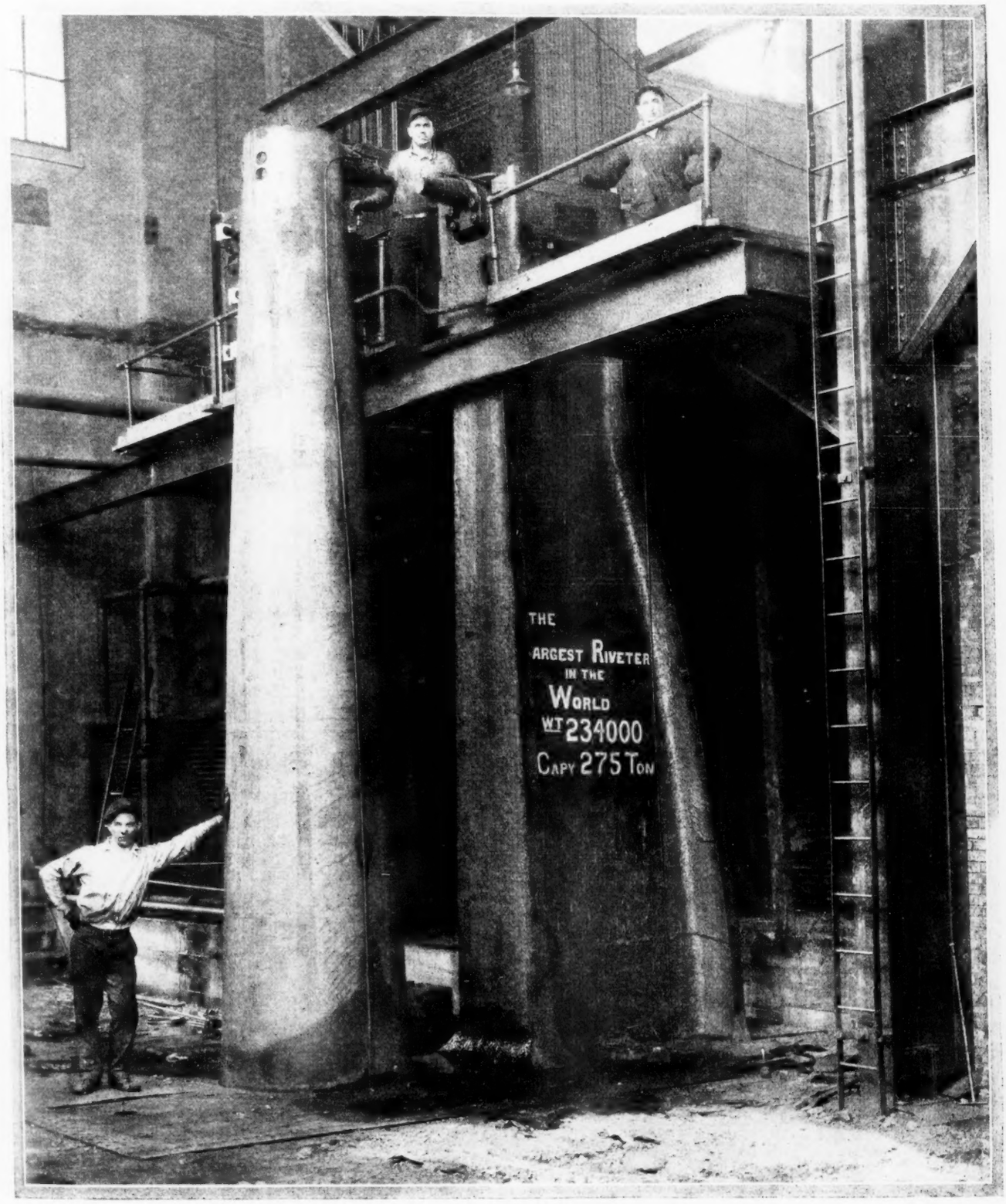


Photo courtesy *Power Events*

World's Largest Riveter

Recent developments in heavy-plate pressure vessels have made it necessary to install this giant riveter—capacity 275 tons—in the Louisville, Ky., plant of the Henry Vogt Machine Company. The cast-steel outer stake alone weighs 82,000 lb., while the total weight of the riveter is 234,000 lb.



How One Concern Solved the Problem of

Power for a Small Plant

BY G. H. KIMBALL

BY PURCHASING all the power in the non-heating season and generating enough power during the heating season, more than $10,000 a year was saved over the previous practice of generating power all the time. The new arrangement also provided a reserve capacity that insured the essential continuity of electric service.

FOR the very small plant the question of whether the power shall be purchased is easily answered in the affirmative. On the other hand, with a plant of, say, 500 kw. capacity, where the exhaust steam is used in process work, the answer is equally clear. However, where a plant is generating all its power and can use the exhaust steam during the heating period, it may be difficult to decide whether it will be better to purchase all the power all the time or to install more efficient generating equipment and effect economies that would be permanent.

How this problem was met by one concern is here related.

Where the regular maintenance crew is used to make the usual repairs to the building and other necessary parts of the plant besides the power equipment, it is often difficult to allocate the charges. Therefore some of these charges are omitted in this statement, but for comparison the figures should not affect the conclusions.

The power plant contained three hand-fired 72-in. by 16-ft. return-tubular boilers, carrying 100 lb. pressure. These supplied steam to two slow-speed engines of the same make, direct-connected to 250- and 100-kw., direct-current generators, respectively; also a high-speed engine, direct-connected to a 125-kw. generator. For light loads at night and Sunday there was a 25-kw. turbine generator.

Increase in Load Took up Reserve Capacity

At the time the writer became connected with the plant, the load was about 250 kw., so that it would be considered that the plant had duplicate generating equipment. The load increased to such an extent that four years later it was often necessary to run all three of the larger units. From time to time the central-station representatives had approached the management with regard to supplying power, but on account of there being no meters to show the total requirements, it was difficult for them to base their proposition on the ammeter readings alone.

The central station furnished alternating current, so that before the matter could be carried out, either a motor-generator must be used or all the motors, of which there were about three hundred, must be changed. If the power company would have agreed to charge for the direct current delivered at the switchboard by the motor-generator at a price comparing favorably with the cost of generating it in the steam plant, it is probable that their proposition would have been acceptable.

The company owning the plant were not much concerned about the matter either way since the operating costs of the power house were about 2½ per cent of the total costs of production. The management did favor the idea of generating its own power and wished to have a duplicate source of power in order to have no interruption of service.

Since the central station did not seem able to meet the situation with a substantial saving, the aim seemed to be a more efficient generating plant. It is well to state here that the process steam used amounted to little and a pressure of at least 50 lb. per sq.in. was necessary. The boiler plant was first considered and two modern 3,000-sq.ft. water-tube boilers, built for 200 lb. pressure, were installed. The pressure on the old engines was limited to 125 lb., but the piping was arranged so that when a new generating unit was installed, a reducing valve could be put in to supply the two engines that would be retained, while the new unit would be supplied with full boiler pressure.

Estimates on Increased Generating Capacity

When the time came to consider the increase in the generating capacity, estimates were obtained on uniflow engines and turbines, and it was immediately seen that, during the non-heating season, a condenser would be desirable from the point of economy and if water were obtained from the river near by, at least 1,000 ft. of 12-in. pipe would be needed for intake and discharge lines. It was estimated that a complete unit of 500 kw. capacity would cost in the neighborhood of $40,000 to install. If this were done, the 250- and 125-kw. units would be retained, and for some time they would be able to carry the load using 125 lb. boiler pressure. This would provide duplicate plant capacity.

At this time the central station again approached the company with a view to analyzing the situation to see if purchased power could be used to advantage. A study was made of all the applications of power and light. It was at once seen, however, that it would be too expensive to attempt to change the motors to those using alternating current. Also, where variable speed was required, direct-current motors allowed much greater range and fineness of regulation. The central station then made the following proposition:

At a cost of $18,566, to install a motor-generator set of 300 kw. capacity to use 2,300-volt alternating current and generate 125-volt direct current for power. For lights the alternating current would be supplied through transformers. Since the present plant always kept steam up for a fire pump, they also provided a pump driven by motor to avoid the necessity of keeping steam up nights or Sundays. No provision was made for a small unit to run when the load was light, and little thought was given to the maintenance of the boiler plant with the rest of the necessary equipment to supply steam heat. There had been three regular firemen employed and one man who filled in for three

days, so that the others should not work over six days a week. In addition to this the janitors did some cleaning work in the power house. The central station provided for one fireman to cover the boiler plant during the heating season.

Since they recommend shutting down the engines and purchasing all the power, the question then remained: Who would do the cleaning and other maintenance work? This is where unwary purchasers fail to analyze such offers carefully, for after a contract has been made they find that there are still some charges that did not appear on the proposition as presented. The summary of the central station follows:

Coal	$6,300.00
Electricity	22,942.68
Labor	1,976.00
Water	161.00
Interest	1,140.00
Depreciation	970.62
Maintenance	415.98
Taxes and insurance	277.32
Supplies	150.00
Total	$34,333.60

These figures were based on a consumption of 72,000 kw.hr. per month. The fixed charges and maintenance are based on the new equipment only.

After consultation with an electrical engineer, the writer in collaboration with him analyzed the central-station report and the following recommendations were the result:

That the present 250- and 125-kw. units be operated during the heating season to generate power and supply the heating system with exhaust steam. In addition to the 300-kw. motor generator, that one of 100 kw. capacity be procured for the light-load periods, and arrangements made for the lights to be on double-throw switches so that either current could be used.

With this arrangement there would be practically a duplicate plant for power and lighting available and there would be the two sources of current for lighting. The steam generated for heating could generate a certain amount of power on its way to the heating mains. To install the necessary apparatus, it was estimated that the cost would be $27,800. Based on purchasing 618,300 kw.-hr. and generating 181,000 kw.-hr. per year by steam, the following summary is given:

Coal	$7,000.00
Electricity	13,000.00
Labor	5,500,000
Water	200.00
Interest	1,700.00
Depreciation	1,700.00
Taxes and insurance	600.00
Supplies	200.00
Maintenance	300.00
Total	$30,200.00

Fixed charges are based on the new equipment, other charges on all the equipment. The fuel charge is based on coal at $10 per net ton.

Having decided to accept this proposition, additions to the piping and wiring brought the final costs up to a total of $33,309.16.

Regarding labor, two of the firemen were retained during the first winter, and an engineer who would do his own firing was put on the night shift from 11 p.m. to 7 a.m. Since the firemen had worked under an agreement with a labor organization, it was not thought expedient to reduce their wages or increase their working day. Since the chief engineer had been with the company many years and would be retained anyway, he continued to operate the machinery in the engine room and answer the calls for maintenance men as he had always done. After the heating season had passed, one fireman and the night engineer were laid off and the other fireman, who had also been with the company for many years, was kept on to make what steam was needed for process work, lavatories and warming ovens. His total hours were somewhat increased, but he could leave at noon Saturday and had all holidays off. No account had been taken of the cost of removing ashes, so that in the final summary of actual charges that item has been added as follows:

Coal	$6,819.92
Labor	7,937.99
Electricity	15,841.57
Water	99.02
Interest	1,998.54
Depreciation	1,998.54
Taxes and insurance	666.18
Maintenance	255.40
Supplies	282.84
Ash removal	104.38
Total	$36,004.38

With the old engine plant to generate 706,555 kw.-hr. per year, from past figures, it was computed that the cost would be $43,500, so that with the estimated expense of $30,200, the saving would have been $13,300 per year.

Over Ten Thousand Dollars Saved by New Arrangement

After the plant had operated for one year under the combination arrangement, it was found that the net amount of power purchased and generated amounted to 830,550 kw.-hr. If this had been generated in the old plant, the cost would have been $49,813, so that the difference between this and the actual expense of $36,004.38 is $13,808.62. The cost of coal had decreased so that this difference alone would amount to about $3,000, which sum, if deducted from $13,808.62, would leave a net saving of $10,808.62 per year.

In computing the foregoing results, no account was taken of superintendence, maintenance charges or the maintenance of the physical structure of the building housing the power plant, since this adjoins the main factory building and such repairs as are necessary are charged to the general building account. Also no account was taken of the fixed charges of that part of the old equipment that has not been written off the books. These charges would not affect the net saving, and the idea is to show that the expense of the new installation, when compared, can be written off in less than four years by the saving in operation over what would have been the cost if the use of the old plant had been continued. It is also doubtful if a modern condensing unit, when the expense of maintaining the steam plant for continuous operation at somewhat above normal load is considered, would keep the operating charges as low as they are at present.

BEGINNING with the first issue in May "Power" will begin a series of short practical articles of an educational character. The first of these will tell about the Steam Loop—what it is and how it operates; a second article will tell how to figure the power required to drive a fan; another will explain why a double eccentric is used, etc. Don't miss any of these.

How to Make

Differential Manometers

By A. J. NICHOLAS
Instructor in Mechanical Engineering, The Pennsylvania State College

If you need a manometer in a hurry, it is easy to make a good one out of a few lengths of glass tubing and a bottle

THE choice of a differential manometer for temporary test work in fluid measurement is often perplexing to the test engineer. If the range of pressure is large and a fairly high degree of accuracy is desired, usually several types of manometer and liquids may be used.

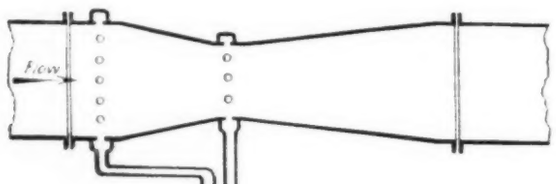


Fig. 1—The plain U-tube is the simplest form of manometer

The bend may be made in the glass tubing, or by a piece of rubber tubing connecting two straight lengths of glass tubing.

For measuring draft or vacuum or other pressure differences, not more than 15 or 20 lb. per sq.in., the use of liquid level manometers is almost universal, and they give the most accurate and reliable results, with a few simple precautions. For a permanent set-up, such instruments will usually be bought from the manufacturer who makes them up in a substantial and good-looking case, arranged for mounting on the wall or instrument board. However, for a test or other temporary or hurry-up job, the engineer will be a bit ahead of the game if he knows how to make up a suitable gage from odd bits of material around the plant, with a possible trip to the nearest drug store for a piece of glass or rubber tubing.

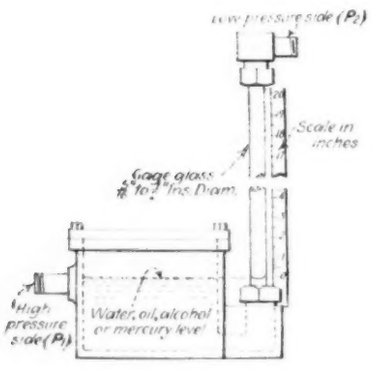


Fig. 2—For measuring small pressure differences in a high-pressure system, boiler gage glass tubing may be used

This article deals with home-made manometers, shows how to make them and tells how accurate they may be expected to be. Naturally, if there is a high-grade manometer around, it will be a good plan to check the home-made device against it, but if this is not possible, a careful man can set up a manometer that will be thoroughly reliable. The important items are to know the specific gravity of the liquid used and to have an accurate scale attached to the tubing at the right place, so that the zero of the scale is at the zero of the liquid. This latter includes leveling or plumbing the gage. Inclined gages have to be set with special care to make sure that the tube has the right slope. A good spirit level is essential.

The illustrations show simply the glass parts and the scales for gages of various types. Of course these must be mounted on a rigid support. Usually, a board or a wooden box will furnish the handiest means for holding the parts in the proper relative positions. The tubing, bottle, etc., can be wired or clamped in place, with bits of rubber sheet packing to prevent crushing the glass.

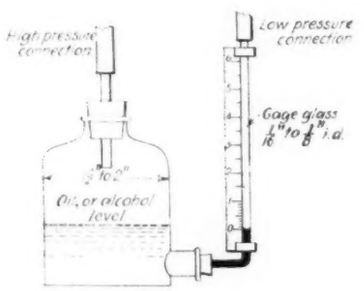


Fig. 3—For low pressures a bottle with a bottom neck makes the job easy

Fig. 1 shows the plain U-tube manometer connected to indicate the differential across a Venturi tube. This type of manometer is suitable for differential measurement of 3 in. or over, with oil, alcohol, water, salt solution or mercury as fluids. The differential should be not less than 3 in. with any of the foregoing fluids, oil and alcohol merely serving to give the corresponding water differentials of less than 3 in. With a least scale division of 0.1 in. and an estimation of 0.05 in., the accuracy of the reading for a 3-in. differential will be 1/60, or 1.7 per cent. If the rate of flow varies as the square root of the differential, the accuracy in the rate will be within 0.9 per cent.

Fig. 2 shows a type of manometer suitable for meas-

urement of differentials from 3 in. upward, the same as the U-tube. The single tube permits of a direct reading of the differential if the zero reading corresponds to the zero mark on the scale. The cross-sectional area of the chamber should be about 100 times the cross-sectional area of the tube. The scale should be drawn to compensate for the drop in the chamber, particularly at

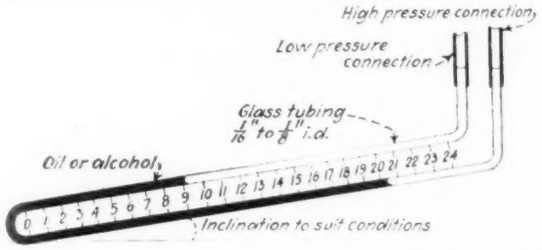


Fig. 4—An inclined scale makes it easier to read to small fractions of an inch

high differentials.[1] This correction can be readily determined from the relation of the cross-sectional area of the chamber and the tube. If the scale divisions are in inches, with 0.1 in. as the minimum value, the same range of accuracy may be expected from the readings as in the aforementioned U-tube.

Fig. 3 shows a type of manometer suitable for measurement of low differentials ranging from 0.5 in. to 2 in. No correction is required for the imperceptible drop in the liquid level in the bottle at these differentials, since the cross-sectional area of the bottle is very large compared to the tube area. The small bore tube, with alcohol or oil as a fluid, gives a very distinct and readable meniscus, which can be readily estimated to

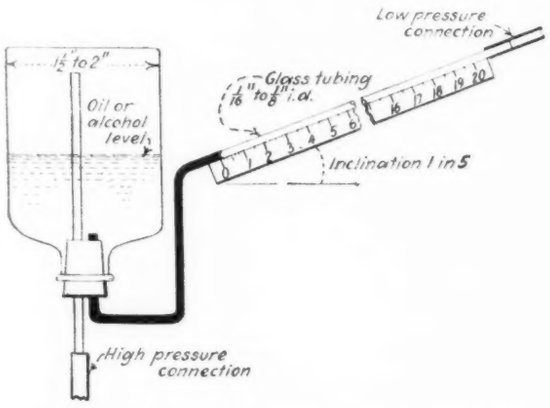


Fig. 5—An ordinary bottle may be used for a temporary set-up

0.02 in. or better. The range of accuracy in the differential measurement may therefore be $\frac{1}{25}$ at 0.5 in. to $\frac{1}{125}$ at 2 in., or 4 per cent to 0.8 per cent. The corresponding rate accuracy of a Venturi meter will be from 2 per cent to 0.4 per cent.

Figs. 4 and 5 show inclined manometer U-tubes suitable for low differential measurements of 0.4 in. to 4 in., using alcohol or oil as fluids. With the smallest scale division of 0.1 in. and an estimation to 0.05 in., the range of accuracy for these limits of differentials and angles of inclination of 10 deg. will be approximately $\frac{1}{50}$ to $\frac{1}{500}$ or 2 per cent to 0.2 per cent. The corresponding rate accuracy will be from 1.0 to 0.1 per cent.

All the foregoing rate accuracies correspond to flow varying as the square-root law. For viscous flow the error in the rate will be the same as the error in the differential, since in viscous fluid flow the velocity varies directly as the differential.

Manometer Fluids

From the results already given it is evident that high accuracy in the differential measurement is most desirable at low differentials. For low differential measurement water is a very unsuitable liquid for

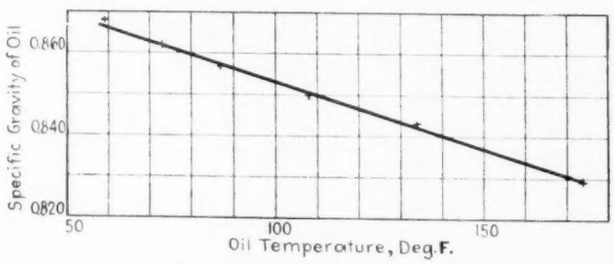


Fig. 6—Typical curve for draft gage oil

manometer purposes, since even with the cleanest gage glass possible, a water meniscus is likely to be sluggish. The capillary action for the size of tubes, as in Figs. 3 to 5 inclusive, would augment the discrepancies, prohibiting the use of this size tubing. For this reason much more suitable liquids are oil and alcohol, since, even for the very small size tubing as shown in Figs. 3 to 5, the capillary action is small or negligible, and the meniscus is distinct and easily readable. The alcohol should be pure and water-free. The oil should be transparent and of low viscosity and vapor pressure. The refined paraffin oils for medicinal use are the best.

Fig. 6 shows the variation of specific gravity with temperature for an oil of this type which the writer has used extensively as manometer fluid for low differential measurement. Such a graph is suitable for conversion of oil differentials into inches of water, which must be done for many calculations. If the type of oil mentioned were used in manometers of Figs. 3, 4 or 5, the conversion of the oil differential to water differential would be as follows: For Fig. 3 manometer,

$$h_d(\text{in water}) = \frac{h_d(\text{cm. oil as read}) \times \text{specific gravity (from Fig. 6)}}{2.54}$$

For Figs. 4 or 5 manometers,

$$h_d(\text{in water}) = h_d(\text{in oil as read}) \times \text{specific gravity (from Fig. 6)}$$

The temperature which the writer uses in connection with Fig. 6 is that indicated by a thermometer placed near the manometer. He believes no appreciable difference of temperature can exist between the air temperature surrounding the tube and oil, and the temperature of the oil in the tube.

[1] For example, if the inside diameter of the tubing is $\frac{1}{4}$ in., and of the bottle $2\frac{1}{2}$ in., the diameter ratio is 1 to 10, and the area ratio is 1 to 100. If the liquid rises 0.99 in. in the tube, it will fall 0.01 in. in the bottle, so that the actual head is 1 in. Accordingly, the 1-in. mark of the scale must be placed at 0.99 in. above the zero, and correspondingly, the entire scale must be made one per cent short throughout, just as a patternmaker's rule is made longer than standard to compensate for the shrinkage of castings. An easy way to lay out a shortened scale is to draw two parallel lines, say 5 in. apart, and graduate them, one in standard inches and tenths, the other in spaces 0.9 and 0.09 in. long. Connect corresponding divisions by straight lines. Then draw nine lines parallel to the scales, dividing the horizontal space between them into ten equal parts. This gives a series of scales ranging from the standard scale at one side to the 10 per cent shortened scale at the other, by steps of one per cent. Obviously, intermediate parallel would give any desired percentage of shortening.—Editor.]

How Electric-Elevator Dual Controllers Operate

BY CHARLES A. ARMSTRONG

ELEVATORS are frequently installed and arranged with a controller that permits of operation from either a car switch or from push buttons. In this article a detailed explanation is given of how one of these control systems functions.

FULL-MAGNET type elevator control may be divided into three general classes: Car-switch; push-button, or automatic; and a combination of the two, dual control. There are many places, such as hospitals, small hotels and apartment houses, and some classes of industrial buildings, where during certain periods of the day the traffic is heavy enough to justify having an operator on the car. At other times there is little use for the elevator, but it will be required by people on the different floors of the building.

The first of these requirements is taken care of by car-switch control and the latter by push-button or automatic control. In a dual system the part of the control equipment used for starting, stopping and reversing the motor is common to both car-switch and push-button operation. The dual system may be considered a car-switch type of control, with the push-button system added.

On the car-switch control the operator starts and stops the car by manipulating the control with the car switch. At the terminal landings a limit stop is provided that will cause the control to function and stop the car if the operator fails to center the car switch. Should these two fail and the car pass the floor a short distance, a final limit switch is opened to cause the machine to stop. In the automatic push-button system of control means are provided, if all the requirements for safe operation are complied with, to start the elevator and bring it to a stop at a floor by pushing a button. After pushing the button, it can be released and the rest of the control is automatic and is effected by the use of a floor-selector switch and floor-selector relays.

The floor-selector switch has a rotating member which is driven from the machine and opens contact as the car approaches the different floors. When the car approaches the floor corresponding to the starting button, the floor-selector switch opens a contact that causes the control to function and stops the car at that floor. A Cutler-Hammer dual controller panel for a squirrel-cage induction motor is shown in Fig. 1. The different parts of the controller are indicated below the figure. A wiring diagram for this type of controller, but with the transfer switch in the car, is presented in Fig. 2. The following description of the controller's operation will bring out the various functions performed:

In describing the controller, operation from the car switch will first be considered and the circuits for push-button operation then explained. The control circuit starts from L_2 terminal on the control panel and passes through the fuse F into the cable and to the N_2 terminal at the top of the controller. From N_2 terminal the circuit continues to the junction box on the controller, then to the up overtravel-limit switch, through the hoistway junction box, to N_1 on the down overtravel-limit switch, then back to the hoistway junction box and to the junction box on the car. From the junction box on the car this circuit is to N on the transfer switch, which in this case is shown in the car. The dotted lines show the position of the transfer switch for car-switch operation. Therefore, from N on the

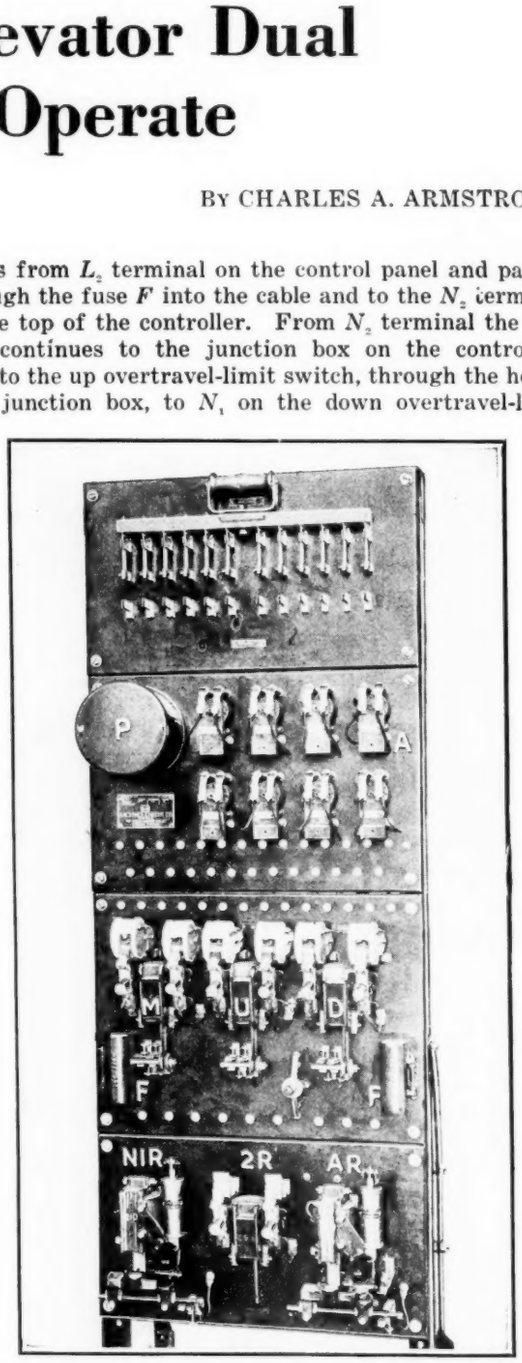


Fig. 1—Panel board for combination car-switch and push-button alternating-current control

For car-switch operation the multipole knife switch at the top of the panel is in the up position and for bush-button control is in the down position. The group of small contactors at *A* are the direction-switch and floor-selector relays. *P* is the phase-failure and phase-reversal relay; *U* and *D*, direction switches; *M*, potential switch; 2*R*, switch to short-circuit the starting resistance; *AR*, timing relay for the 2*R* switch; *NIR*, non-interference relay; *F* and *F*, control-circuit fuses.

transfer switch the circuit is to C and returns to C on the car switch.

Assume that the car switch is moved to the down position; then it will close the circuit between C and 1. From 1 on the car switch, the circuit leads to the junction box in the hoistway and to the down terminal limit switch and returns to 11 on direction relay DR on the controller. The circuit is then through coil D on the down-direction switch, resistance E to terminal X, and returns to X on the car safety switch, through this switch, the car-door contact, stop button in the car, to X_3 and X_1 on the down overtravel-limit switch, through the door safety switches, to the up overtravel-limit switch, the governor switch, to X_{10} terminal at the top of the controller, and to the L_1 side of the line.

In the hoistway junction box a tap is taken off N, which returns to terminal N at the top of the controller and goes to auxiliary contacts D'' and U'' on the direction switches D and U and the center contacts of motor and return from T_2, through the left-hand side of potential switch M to the L_2 line. The brake torque motor is connected to the three lines and is energized when switch M closes, so that the brake is released and the motor starts with resistance R_1–R_2 and R_{11}–R_{12} in series with the stator windings.

Auxiliary contacts M' are opened and M'' closed when contactor M closes. Opening contacts M' interrupt the circuit to coil AR and this relay starts to open, but is retarded by a dashpot, so that contact R' remains closed for a short period. The closing of contacts M'' completes a circuit for coil M, from N through M'', coil M to X, without going through contact R', therefore, when relay AR opens contact R', potential switch M will remain closed.

On closing contact A, a circuit is made for coil $2R$ on the starting-resistance contactor. This circuit is from N, through contacts D'', M'' and A, through coil $2R$ to X and to the L_1 side of the line. Making coil $2R$

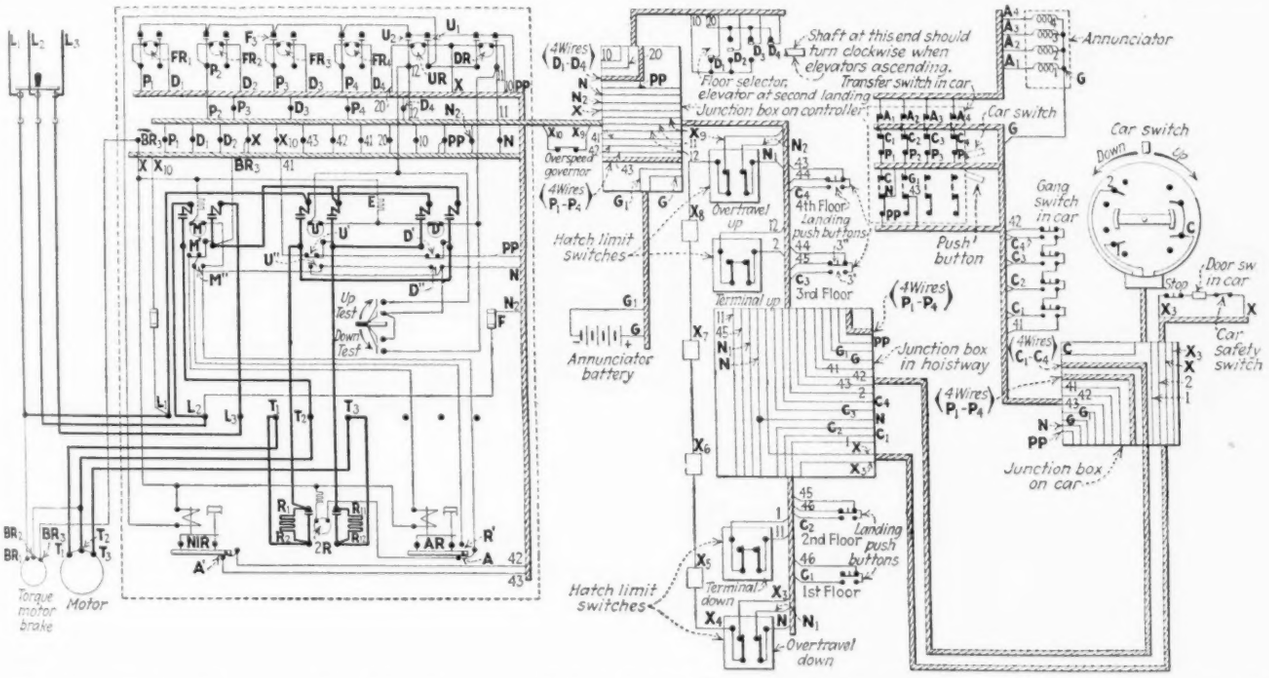


Fig. 2—Wiring diagram of combination car-switch and push-button control for a squirrel-cage motor started through one step of resistance

the test switch. All these are open, so that they can be forgotten for the present.

Energizing the down-direction-switch circuit causes coil D to close its contactor. When this contactor closes, auxiliary contacts D' open and D'' close and complete the circuit for the coil of timing relay AR. This circuit is from N on the controller, through auxiliary contacts D'' and M', through coil AR to X and to the L_1 side of the line as previously explained. Making this circuit alive causes relay AR to function and opens contact A and closes R'. This operation completes the circuit for coil M of the potential switch, from N, through contacts D'', contact R' and coil M to X, returning to the L_1 line as previously traced.

When contactor M closes, it completes the circuit for the motor from L_1 line, through the left-hand side of contactor D, starting resistance R_{11}–R_{12} to T_3 on the motor. Another motor circuit is from L_3, through the right-hand side of contactors M and D, resistance R_1–R_2 to T_1 on the motor. These circuits continue through the alive causes it to close its contactor and cuts resistances R_1–R_2 and R_{11}–R_{12} out of circuit and the motor comes up to full speed. The time of closing contactor $2R$ is controlled by the timing of the dashpot on relay AR.

On this controller the push buttons at the landings are so connected that they are used for signaling the operator when the machine is under car-switch control, and bring the car to the floor when the machine is under push-button control. The terminals G and G_1 of the annunciator battery go to G on the annunciator and G_1 on the transfer switch in the car. Assume that the third-floor landing button is pushed when the machine is under car-switch control, this would close contacts $3'$ and open $3''$ and complete a circuit from G on the battery to G on the annunciator, through coil 3 to A_3 on the transfer switch to C_3 on the third-floor button, to 44 on the fourth-floor button, and return to 43 on the transfer switch and to G_1 on the battery. This completes the circuit to operate the third-floor call on the annunciator, as on the ordinary system of signaling

the operator. The other call circuits may be traced out in the same way.

To change from car-switch control to push-button, the only operation necessary is to throw the transfer switch, which in Fig. 2 is in the car. The full-line connections between N and PP, C_1 and P_1, etc., show the position of the transfer switch for push-button control, which will now be considered. The floor selector switch is shown in the position that would obtain with the elevator at the second floor; that is, contact D_2 is open. Assume that the car is at the second floor, with the gate and doors closed, and that the landing button on the third floor is pressed, which will open contacts 3″ and close 3′ on this button.

The control circuit from L_2 on the controller to N on the transfer switch is common to both the car switch and the push buttons. From N on the transfer switch, the circuit continues to PP terminal at the top of the controller. There are two leads from this terminal, one of which goes to the top contacts of the floor selector relays, and the direction-switch relays, all of which are open.

The other branch from PP goes through the top auxiliary contacts of the direction switches to terminal 41 and returns to 41 on the push buttons in the car. From here the circuit continues through all these buttons in series and returns to terminal 42 on the controller. Continuing, the circuit passes through contact A' on relay NIR and to 43 on the fourth floor button, to 44 on the third floor button, through contacts 3′ to C_3 on the transfer switch, and returns to terminal P_3 on the controller. This circuit is completed through the

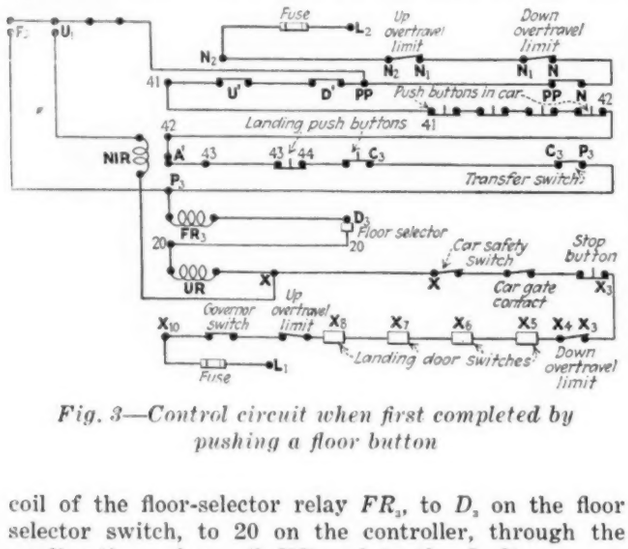


Fig. 3—Control circuit when first completed by pushing a floor button

coil of the floor-selector relay FR_3, to D_3 on the floor selector switch, to 20 on the controller, through the up-direction relay coil UR and to the L_1 line as explained for the car-switch control.

Energizing the coils of relays FR_3 and UR causes these relays to close their contacts. The right-hand contact of UR closing, completes a circuit for the non-interference relay NIR. This circuit is from terminal PP at the top of the panel, right-hand contact of relay UR, through coil NIR to terminal X and to the L_1 side of the line. When this relay opens its contact A', it cuts all the push buttons out of circuit and prevents the operation of the machine being interfered with from the push buttons when the car is in motion. The push-button part of the control circuit is short-circuited by closing any one of the floor relays, in this case by closing the contact of FR_3. This completes the circuit from PP, through contact F_3, coil FR_3 to D_3 without going through the push buttons.

This operation will be more clearly seen by referring to Fig. 3, which shows the control circuit just described in simplified form with the non-interference relay contacts NIR closed. This circuit can be easily followed through from L_2 at the top of the diagram to L_1 at the bottom. Fig. 4 is similar to Fig. 3, but the F_3 and U_1 contacts are closed and A' opened. The closing of U_1

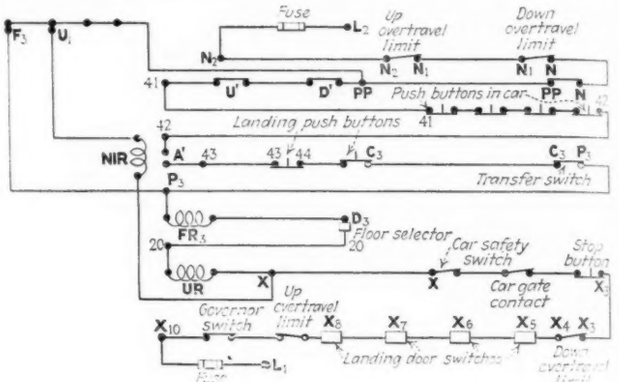


Fig. 4—Control circuit after floor-selector, direction-switch and non-interference relays function

contact completes the circuit for relay coil NIR, and closing contact F_3 completes a circuit from PP to P_3, which shunts out of circuit auxiliary contacts D' and U' on the direction switches, the push buttons in the car, NIR relay contact A', landing push buttons, and the transfer-switch contact. Therefore, when relay FR_3 closes and NIR opens, further control of the car is taken away from the push buttons, so that after the car is once started from a push button it will go to that floor and stop before it can be controlled by another button.

Closing contact U_2 of direction relay UR completes the circuit for the up-direction switch coil U. This circuit is from PP through contact U_2, coil U of the up-direction switch, to X and the L_1 side of the line. Making the circuit alive causes the up-direction switch to close. Auxiliary contacts U' are opened and U'' closed, when the direction switch closes. The closing of auxiliary contacts U'' makes the circuit for timing relay coil AR, from N, through contacts U'', and M', coil AR to X, and to the L_1 side of the line. From here on the starting of the motor is the same as explained in the car-switch control.

When the car approaches the third floor, contact D_3 on the selector switch is opened and causes the car to stop automatically at the floor. By referring to Fig. 4 it will be seen that when contact D_3 opens, it breaks the circuit through relay coils FR_3 and UR. When these relays open, they interrupt the circuits to up-direction switch U and to the non-interference relay NIR. On the non-interference relay there is a dashpot to delay the closing of contact A'. After the elevator stops, it cannot be started again until contact A' closes; therefore, by delaying its closing it gives those operating the car time to open the gate and door and prevent the car from being started from another push button until they are through with the car. After the landing door and gate have been closed, the car is available for someone else on another floor, or it may be boarded at the floor where it is located, the door and gate closed, and the car started to another floor.

Writing Off Machine Investment

A DEAL of false reasoning is indulged in when depreciation of machinery is under consideration. This frequently leads to an increase in the cost of power.

There are two forms of depreciation—one actual, and the second that set up for bookkeeping convenience.

Many factory managers prefer to write off an investment in new power equipment in five years or so. This avoids having a machine worn out before its initial cost has been written off. However, when comparing the operating costs in after years with the cost with some other machine or with purchased power, if one is not careful an error may be made.

If after five years an engine is good for five years more, it is obvious that the yearly depreciation charge has been too high, causing the cost of power to be placed at too high a figure. If the old machine is continued in service, the power costs will average out so no great harm is done.

On the other hand, if the machine is discarded while still usable, the new method of obtaining power must be charged with the proper depreciation of the old unit, even though its initial investment has been written off on the books. If the old machine has run five years and is believed to be good for another five, the new power source should be charged annually with ten per cent of the cost of the original unit plus the average interest.

Beware the New!

IN THESE days of rapid advance new things are "breaking" far more frequently than in the time of our grandfathers. That is good.

There is a tendency on the part of many to seize upon the new thing and abandon the old, for no reason at all, but simply on impulse, because the new is new and the old is old. That is bad.

Engineers are ordinary human beings, and like their brothers, they decide all sorts of questions on impulse, or feeling, or "hunch." In small matters few men think out a rational course, and even in larger affairs many men fail to think things through.

Especially is this true in fields where one's knowledge is scanty. The operating engineer may plan expenditures for equipment that shock his employer, who must find the money. Happily, the employer, being on top, vetoes the project, and the false step is avoided.

On the other hand, the company executive, as often as not a man with banking or legal training and experience, sometimes plans a disconcerting array of equipment for his plant. Unfortunately, the engineer can do little but protest, and the pity is that his protest is not always heard by those who need it.

It is this executive who is peculiarly likely to select plant apparatus on impulse, to pick the new thing just for its novelty.

How can the idea be "put over" to these non-technical executives? They should know that the new is not necessarily better than the old, at least not under all circumstances. And that the assumption that the new is susceptible to greater improvement than the old is not always justified. And that the argument from current practice or fashion is merely a contention that because nine men have blundered into good or bad fortune, the tenth should shut his eyes and join them, for better or for worse. And that it is better to save money with an old type of outfit than to squander it with the latest invention.

If you can educate your boss, you may save yourself a world of grief. The time to do this is when there is no change in sight. And when the change is in the offing, watch *his* step!

Should Basic Steel Be Used in Boilers?

C. E. STROMEYER, Chief Engineer of the Manchester Steam Users Association of England, in his annual report of 1916-17 suggested that certain cases of the so-called caustic embrittlement in boiler plate that had been experienced in England and elsewhere might be due to the fact that steel made by the basic process had been used for the plates of these boilers. He discusses this subject again in his report of 1922 and points out that basic steel may contain nitrogen, which he considers a cause of weakness. Mr. Stromeyer believes that the sum of the per cent phosphorus plus five times the per cent nitrogen in the steel should not exceed a given amount.

A recent issue of *The Metallurgist*, a British publication, contains a discussion of this subject. The article points out that embrittlement failures have been frequent in Germany and in the United States, where much basic steel is used for boiler construction. In England, on the other hand, boiler plate is usually made of acid steel and, strange to relate, failures by embrittlement have been relatively few. The writer calls attention to this remarkable coincidence and suggests that there may be some, as yet, undetermined connection between the character of the steel and its liability to failure under stress in the presence of solutions of high causticity.

Since so little is really known of the true nature of this caustic embrittlement, this factor would seem at least to warrant further study and investigation. The difficulty is that we know little about the real structure of the grain in any steel. When a metal is cooling from the fluid state, it is generally assumed that the grains reject impurities to their boundary surfaces. A grain of steel undergoes many changes in cooling from the liquid state, and these modify its properties in a marked manner. What is the nature of the cementing material between steel grains, and how does the structure of the grain itself vary? Possibly these character-

istics are influenced by the different processes of manufacture, acid or basic. An answer to this question may also assist in explaining the action of caustic on steel.

These indictments of basic steel should not go unnoticed. What have our boiler manufacturers to say with regard to the relative values of basic and acid steels for boiler plate? Can our steel manufacturers explain what are the essential differences, if any, in the grain structure of steels made by the two processes? Will our scientists be able to deny or confirm the statement that the two steels act differently under stress in the presence of caustic solutions?

Organized Labor Interested in Elimination of Waste

BEGINNING the afternoon of April 9 and ending the following day, there was held, at the Labor Institute, Philadelphia, under the auspices of the Central Labor Union of Philadelphia and the Labor Union College of Philadelphia, a series of meetings which seem likely to become an outstanding feature of our industrial history.

The meetings were called a "Conference on the Elimination of Waste in Industry," and addresses were made in the Auditorium by labor leaders and by engineers and at a dinner by an industrial engineer, a past-president of the Amercian Society of Mechanical Engineers and a member of the Committee on Elimination of Waste in Industry, by the first vice-president of the American Federation of Labor, and finally by a well-known economist, Irving Fisher, Professor of Political Economy at Yale. Five members of the A.S.M.E. appeared upon the printed program, three of them also members of the Committee on Waste.

It will be recalled that at a dinner a few years ago to the delegates assembled at Washington to form the American Engineering Council, Mr. Hoover announced that Samuel Gompers had signified to him the readiness of organized labor to join in an effort to eliminate waste in industry.

Although during the discussion of some of the addresses given at the recent conference there was an occasional note indicating that there were union men and women who did not fully comprehend what it was all about, there can be no doubt that the speakers chosen did understand it fully and that, so far as the high officials of union labor in Philadelphia and higher officers of the American Federation of Labor are concerned, they do fully understand it and firmly believe that by co-operating with engineers and employers in the elimination of waste, benefits will come to labor, employers and to the public.

Indeed, if there was one outstanding note of the entire series of meetings, it was that all three of these groups of our social organization must be benefited by scientific study of industrial problems and co-operative effort to remove all obstacles tending to prevent the attainment of the highest possible efficiency consistent with the maintenance of physical and spiritual welfare.

No better presentation in any of our technical or engineering societies of the fundamental principles of Waste in Industries is recalled than that given by Gustave Geiges, President of "Full Fashioned Hosiery, No. 706," Philadelphia. This is an industry in which, owing to the expensive material mostly used (silk) and the very delicate, complicated and expensive knitting machines employed, the utmost care and vigilance are needed on the part of the operators and the highest possible skill must be available for the maintenance of the machines, else defective stockings will be made. And the difference in price received by the manufacturer for the first and for the second quality product is more than the labor cost of producing either of them.

The address of the engineer and of the economist at the dinner were closely listened to and evidently clearly understood and appreciated.

The last address of the conference was by President Green of the American Federation of Labor, in which he pledged himself and his organization to the promotion of ways and means of avoiding industrial waste, insisting of course, that labor must, along with the others, secure a fair share of the benefits.

Whatever may be the prevailing sentiment of the rank and file, there can be little doubt that among the officials of the unions represented, the sentiment is strong for all possible elimination of waste in industry, and this may have the most far-reaching and important results.

Why Not Follow Theory?

AFTER it has been conclusively proved that dry compression is more economical than wet compression in refrigeration, the latter practice still has a large following. Many have a disdain for theory and are prone to follow what is accepted as general practice. Theory is not a statement based on idle fancy, but is an explanation of the cause of observed occurrences. It is, then, in no way a conflict with practice, but is indeed a declaration of what results from a given cause of action. Engineers make a serious mistake in assuming that practice is contrary to theory.

The difficulty is that what is the general practice and what is economical practice often are not identical. Years ago, when mechanical refrigeration was in its infancy, those who operated such plants had no general theory as a guide and blindly followed practices apparently successful in other plants. Wet compression, or the injection of liquid ammonia into the compression cylinder, was one of these operating fetishes, the claim being that this liquid in evaporating would serve to keep the cylinder contents low in temperature, to reduce the horsepower per unit of duty and to permit a greater volumetric efficiency. This fallacy persists today, although numerous closely attended tests prove the contrary and support the theory that dry compression is more economical.

The pioneers really had some justification for wet compression. The machine work of the compressor was far from being high-grade. Piston rods were notorious for their tendency to run hot, and if the use of liquid injection kept them cool, who will blame the operator if he opened up the injection valve? Doubtless, the liquid, by reducing the friction losses, actually reduced the horsepower input. With present-day workmanship and better designs of piston rod packing, friction is so low that this liquid is not needed. Still, in half of the refrigerating plants using Linde-type compressors, the liquid valve will be found cracked a little.

Why do people talk of generators in kilowatts and of motors in horsepower? Both terms are measures of the same thing.

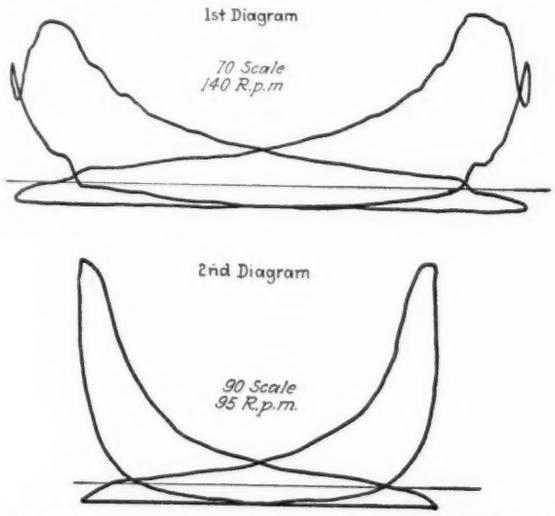
Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Eliminating a Heavy Pound in a Uniflow Engine

A compressed-air unit in our plant consisting of a duplex uniflow engine connected in straight line with duplex compressors, size 20x26x24 in., had a heavy pound in the main bearings since it was put into operation about two years ago.

One set of main bearings was ruined through tightening and burning the bearing metal in an attempt to eliminate the pound, which sounded as though the bearings were loose. This made conditions worse and necessitated the renewal of these bearings.



Diagrams obtained before and after readjusting the valve gear

With the new bearings carefully scraped and fitted, the engine continued to pound under load at all speeds. I was given charge of this unit when the new bearings were being broken in and I immediately indicated the steam cylinders and found that the admission was late on all valves, as shown by the diagram No. 1. After advancing the cams a little two or three times and setting them closer together, the admission was earlier, as shown by diagram No. 2. The setting of the valves made the unit run smoother, but did not eliminate the pound. I went over the bearings and keyed them as closely as possible, with no results.

One night when the load was light and was being carried by another unit, we removed the cylinder head from the steam cylinder and tried the piston nut with a wrench and sledge. It was found tight. I tried a 0.002-in. feeler between the piston and nut, but could not get it between them. I had one of the men bump the piston with the sledge, and by doing this I could readily get a 0.004 in. feeler between them. This led me to believe that the nut was tight on the rod and not against the piston. We tried to back off the nut to see if it was up on a shoulder on the rod at the end of the thread; but it was so tight that by heavy sledging it moved off but very little.

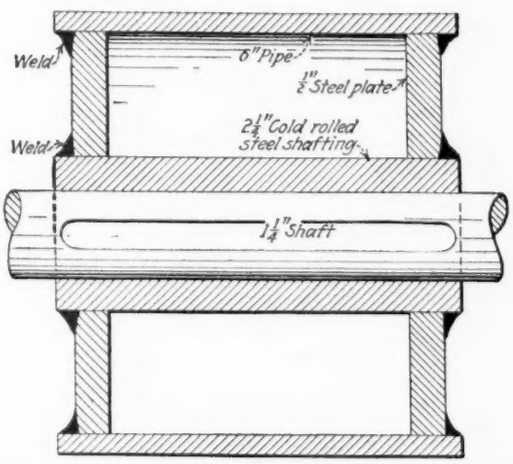
We then expanded the nut by heating with an acetylene torch and drove it on one flat of the hexagon nut. Again, testing with the feeler and bumping the piston with the sledge indicated that the nut was tight against the piston. After running the unit at various speeds and loads, the pound was gone and it has not returned in two months' operation of the engine.

Buffalo, N. Y. RALPH FONTAINE.

Making a Pulley on Short Order

One day we had to have a 6½-in. pulley in a hurry. There was no time to wait for a casting to be made or send to the city for one. We therefore looked about the shop for material out of which to make one. A piece of 6-in. iron pipe, a piece of ½-in. steel boiler plate and a piece of 2½-in. cold-rolled shaft proved to be what we needed.

We chucked the pipe and shaft in the lathe and squared the ends so they would sit up straight on a horizontal faceplate. Then we burned two rings out of the boiler plate to fit the outside of the shaft and the inside of the pipe. We assembled them carefully so as to have the piece of shafting in the center of the pipe, in order to keep the finished pulley fairly well balanced, and then welded them together as shown in the illustration. After that we turned down the outside, bored out the inside and cut the keyway. The finished job cost considerably more than would a pulley purchased outside, but it pulled us through in a pinch. Similar pulleys could be made to the outside diameter of any standard pipe and there is sufficient material to give them a crown if needed.



Pulley constructed from pieces of pipe, boiler plate and shafting

A. B. NEWELL.

Woodbury, N. J.

Bronze Welding a Gas-Engine Head

From time to time it was necessary for the engineer in a large pumping station to remove and replace one or more of the heads on his heavy-duty gas engines. The heads had developed cracks in the exhaust opening and in time leaked so badly they could not be used.

A little over a year ago the firm purchased an oxy-acetylene welding and cutting outfit, and at that time nine of the cracked heads had accumulated. Each cost

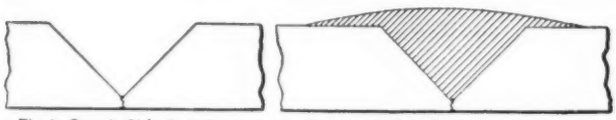


Fig. 1, Crack Chiseled Open Fig. 2, Welded With Bronze

How crack in head was prepared for welding and the finished job

about $200 when new, so when the service engineer of the manufacturer came to instruct the mechanic in the use of the welding and cutting outfit, he was shown the cracked heads.

There were no facilities for preheating, so the service man decided to bronze-weld the heads. Welding rods of $\frac{3}{16}$-in. Hungerford bronze with Almalagan flux were used.

By the way of preparation the cracks were chiseled open in a V almost the entire thickness of the metal, as shown in Fig. 1. The sides were chipped bright for about an inch all around the cracks.

A No. 8 tip in the torch was used with a slightly reducing or carbonizing flame. The weld was started at the inner end of the crack, and as soon as the iron assumed a dull red color the end of the bronze rod, which had been previously dipped in the flux, was placed under the flame.

A thin layer of bronze was flowed over the cast iron to "tin" it. Then the crack was flowed full and some run over the edges, as shown in Fig. 2. In this manner the weld was carried to the outer end of the crack. After being welded, the heads were allowed to cool slowly, and it was noticed that none of them developed any further cracks.

Two of the heads were at once installed so that it could be observed how the welds would stand up in service. They are giving the same service as new heads, and it cost about only $7.50 each to reclaim them.

Clearfield, Pa. J. F. ELDEE.

Do not Fail To Inspect All Parts of Your Equipment

In most power plants there is, or should be, a schedule by which the equipment is examined at regular intervals. Glancing over this list, it may appear that it includes every important part of the equipment. Unfortunately, it usually does not, owing to the fact that some of the parts require inspection only once a year or once in two years. I have reference to the pressure plugs that convey the lubricating oil through the cylinder walls of the modern Diesel engine.

The sight-feed lubricator supplying an engine indicated that the cylinders were getting sufficient oil, but despite this indication one piston and liner were slightly scored. The ball checks at the plugs were examined and found to be in good condition. The pressure plugs were removed and the cause of the trouble was apparent. On the cylinder that was scored, sufficient carbon had deposited in the oil passage to close the opening.

A good way to determine if this condition exists, without removing the plugs, is to disconnect the lubricator from the driving shaft and operate it by hand. It should not require much energy to operate the lubricator if the passages are clear.

Another condition that may arise unnoticed is the condensation of oil vapor lodging in the vent pipe between the crankcase and oil filter. This prevents the oil from returning to the filter fast enough to insure sufficient lubrication of the main bearings. It is advisable to blow this pipe out at least once every two months. ARTHUR K. GENTZLER.

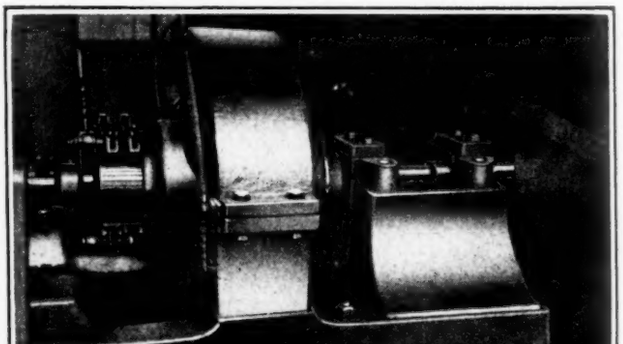
Wisner, Neb.

New Application of an Old Lighting Set

In a plant of the New York Central Railroad the lights and current for some small tools were supplied from a generator driven by a small steam engine. The engine was so wasteful that its drag on the boiler was a serious handicap. This trouble was overcome by an executive who one day spied an old train-lighting outfit stored away in a shed.

The generator set was made up of a marine-type gasoline engine mounted on a heavy base and direct-connected to a 10-kw. direct-current dynamo. Such sets were placed in the baggage cars of New York-Chicago trains when the railroads first adopted electric lighting. Entirely satisfactory at the time, the set was taken out when better lighting equipment was perfected and, along with several others, was stored in a building adjoining the shop.

The set was brought out and assembled in the room that houses the steam-plant auxiliaries. Mechanically, all the parts were in good shape, but as it was not intended to use gasoline power, the engine side was



The rebuilt lighting set

stripped down to the caps of the main bearings. Then a straight shaft was put in place of the crankshaft and coupled up to the armature, its free end being made long enough to receive a pulley. By extending the main line shaft through from the machine shop, power was available for driving this generator set.

Thus a reliable source of current was obtained at a nominal cost. The load on the boiler is relieved, as the main Corliss engine is more economical than the small unit and handles this extra quite easily.

Middletown, N. Y. DONALD A. HAMPSON.

Comments from Readers

Cracks in Plastic Refractory Furnace Lining

Referring to the letter by William G. Alton in the March 29 issue, on "Cracks in Plastic Refractory Furnace Lining," I am of the opinion that it might be possible to build furnace linings in such a way that they will not crack. Why can't it be done in a manner similar to the construction of boiler baffle walls in which thin corrugated sheet-metal separators are used? These separators provide positive expansion joints and prevent cracking in baffle walls, which are surely subjected to greater expansion and contraction stresses than are furnace linings.

I can see no reason why this type of separator cannot also be used to advantage in a wall. It might necessitate anchoring the layers of refractory lining to the outside wall, but that can be done in about the same way that firebrick linings are anchored to outside walls.

Whenever anything has a natural tendency to crack, such as concrete sidewalks and roads, furnace linings, baffle walls, etc., expansion joints should always be provided.

W. F. SCHAPHORST.

Newark, N. J.

Air or Vacuum Chamber on the Pump Suction

My attention has been attracted by an item at the bottom of the second column, page 472 of the March 29 issue. Quoting from this item, we have the sentence, "Properly speaking, there is no such thing as a vacuum chamber on a pump." The statement seems somewhat ambiguous since there is nothing in the remainder of the article to indicate why the chamber placed in the suction line might not be considered as a vacuum chamber, although it is stated that the action of the suction air chamber is the reverse of that of the air chamber placed in the discharge side.

Assuming that the source of supply is below the level of the pump, water is forced to the pump by atmospheric pressure acting on the surface of this source of supply. Before this action can take place, it is necessary to reduce the pressure in the suction line to a point at which the combined action of the water column and air pressure will not equal the action of atmospheric pressure. Consequently, the pressure in the suction air chamber must always be less than that of the atmosphere.

It is customary in engineering practice to speak of any pressure below atmospheric as vacuum, and consequently the term "vacuum" in connection with the suction air chamber would seem sufficiently warranted.

The item referred to will be misleading to many engineers and students, especially so since the term "vacuum chamber" is quite generally applied in textbooks to this vessel. For the sake of clearness I should like to see a further explanation of this item.

Scranton, Pa. R. B. SMITH.

Rule of Thumb Is Passing

The letter by John E. Gaare in the March 15 issue on "Rule of Thumb Is Passing" is timely. It shows that it is time for some grade-school or high-school engineers to wake up and analyze their position. This is no time to be knocking the college-trained man or lamenting your failure to be one. Instead, let us go down the line with him. How can we do this? Here it is.

On my desk I have the latest books on engineering. They are the works of noted engineers from as far back as 1886 brought up to the present day. Then there are some good correspondence schools (I am a graduate of one) which give good courses in engineering, and this is in fact technical training. And in every city there is the night school. All this does not take a fortune to acquire. If the young engineer, or older for that matter, with limited education will spend two or three hours a few evenings each week studying what the other fellow has learned and is learning all the time, instead of helping to hold up the corner lamppost or spending his evenings at the near-by pool room, he won't have to worry about his salvation. The day is here when success requires that the engineer do his work just a little better than the man before him.

Louisville, Ky. FRED E. BOND.

Fineness and Structure of Pulverized Coal

The abstracted article on the "Fineness and Structure of Pulverized Coal," by Rosin and Rammler, in the March 15 issue touches on a matter of increasing importance. Lack of definite knowledge of the subject character is an existing handicap in the development of pulverized coal. The authors draw two broad conclusions: (1) The composition of pulverized coal is practically independent of the kind of coal, the method of grinding and the method of separating; (2) the physical structure of the coal exerts a powerful influence on the shape and surface character of the resulting particles.

Assuming the first conclusion of Rosin and Rammler to be correct, I would express the result in terms of the single remaining variable, the degree of pulverization. Thus we may say the composition of pulverized coal depends practically entirely on the degree of pulverization. It immediately becomes necessary to define what we mean by degree of pulverization. This may mean the ratio of the solid volume of pulverized coal to the total number of particles, or a ratio using weight instead of volume, or a ratio giving the average surface per particle, etc.

We know that as the average size of the particles decreases, the composition tends more and more to uniformity of size. Thus the ratio of coal through 200 mesh to that through 100 mesh may be 70 per cent for one degree of pulverization. But expend some more power and the ratio becomes 80 per cent. Keep on increasing the power and the ratio becomes 100 per

cent. (The ratio in this case is the index of the degree of pulverization.) We may go a step farther and say the composition of a given pulverized coal depends entirely on the amount of power expended on it. This conclusion would seem to follow if Rosin and Rammler's first conclusion cited is correct, and proper account is taken of moisture.

We have, then, two important characteristics of coal which it would seem should be tabulated for all coals: First, the power required to produce a certain fineness; second, the shape and surface character of the resulting product. It would seem that the time is at hand when organized action toward such classification of coals should be undertaken.

The only published microscopic study of pulverized coal in the United States with which I am familiar, is that of L. V. Andrews in the May, 1925, issue of *Mechanical Engineering*. Andrews attempted no broad generalizations, but emphasized that the screen-test method of indicating the fineness of coal was ineffective and misleading. If the work of the German investigators is correct, then only one more item of information is needed beside the screen test, and that is the power required. Thus it would seem we might classify a coal by simply saying it required 17 kw.-hr. per ton to get a ratio of 80 per cent. The 80 per cent would be the ratio of the quantity passing through 200-mesh screen to that passing 100-mesh.

In all probability the solution will not be so simple as this, but something along the foregoing line would seem to be a step in the right direction, because it appears that some coals require about twice as much power as others. Variation in power requirements from 12 to 24 kw-hr. per ton is a matter of considerable interest. Standardization work along the line herein suggested would eventually mean a power-fineness curve for each coal and the elimination of a large amount of guesswork. Also, it would relieve a certain tenseness in the atmosphere. Some think that failure to get fineness and low power requirements at the same time is proof that the pulverizer is of the wrong make. But this is not always the case. If the German investigators are right, it is never the case.

Dayton, Ohio. GUY B. RANDALL.

Keeping Turbine-Generator Slip Rings in Condition

Referring to an article on turbine-generator slip rings in the March 22 issue, by Carl Wildey, after a number of years of power-plant experience I cannot agree with him concerning the care, etc., of collector rings. In the first place it has always been my experience that the negative ring is the one that wears the fastest. The positive brushes wear faster than the negative brushes.

The exciting current, being direct current, is brought to the positive ring from the positive brushes; thereby there is always a tendency for the brush to deposit on the ring, causing more wear on the brush. While this exciting current is passing from the negative ring to the negative brushes, there is a tendency for the ring to deposit on the brush, causing more wear on the ring.

In order to true up collector rings properly, it is best to grind them with the machine running at normal operating speed. It is a well-known fact that a machine running slowly, no matter how tight the bearings are, has a different center of rotation from that when at normal speed. Therefore, if the rings are turned to a true circle at 25 per cent normal speed, the brushes will run smoothly at this speed, but when running at normal speed the brushes will be moved in and out of their holders by the ring which is now running slightly eccentric. This movement or chattering of the brushes causes some arcing which, although not easily seen, combined with the hammering effect of the brush, causes excessive wear on both the ring and brush.

Truing rings and commutators at their normal speed eliminates turning down with a lathe tool, as the surface speed is too great. On slip rings trued by grinding at normal operating speed, it may be found that from the time the machine begins to rotate, the brushes will show signs of end motion until near the speed at which the rings were trued, when the brushes will be as steady as their holders. I have also found that changing the leads to the slip rings as often as once a month causes considerable more wear than a method adopted a number of years back, which is as follows:

Both collector rings are ground down with a wheel and with the machine at normal operating speed; the brushes are then properly fitted and the correct tension put on them. From my experience with copper and cast-iron rings, these will run satisfactorily for at least two years; then it will be found that the positive ring will show practically no signs of any wear and the negative ring will be a little worn. Instead of grinding both rings, I grind only the negative ring and at this time change the leads over and let the larger of the rings be the negative one, and after about two more years' running, this ring will be worn enough to need grinding, and when ground, both rings will again be about the same diameter. This means that one ring will be negative for about two years, then when ground and the leads changed, the larger ring will be negative for two years, then be ground and remain negative for two more years, when this will be ground again and the leads changed.

The foregoing method has been followed and records kept for a number of years on cast-iron and copper rings traveling at 900 and 3,600 r.p.m. respectively on machines running a minimum of 76 hours a week. On machines with steel rings operating at 3,600 r.p.m., there is a lapse of over four years between the grinding of rings and changing of the exciting leads.

The grinding wheel, about 6 in. in diameter, should have the same direction of rotation as the ring to be ground, so that the face of the wheel and face of the ring at the point of contact will be traveling in opposite directions. There are several grinding devices on the market, but sometimes a good one can be made from parts and stock generally found around the average station.

It is a good plan to make a megger check on the rings and field insulation before and after grinding the rings or commutators. It is also necessary in a power station to make megger checks on every piece of electrical machinery at least four times a year, and considerable time and repairs have been saved by making these regular checks as often as once a month and keeping a record of direct-current and alternating-current generators and motors. Finally, the grade of brush used on collector rings and commutators must be selected carefully so as to give good results and best wearing qualities.

South Somerset, Mass. WILLIAM H. BURTON.

Economics Will Give the Final Answer

The editorial in the March 15 issue on "Economics Will Give the Final Answer" contains more practical reasoning than 90 per cent of the discussions on central station vs. isolated plant. When the champions of the two methods start a battle, neither seems to be willing to admit that the other plan holds anything for anyone.

About a year ago a prominent engineering society staged a bout of this sort, and the principles and opinions advanced were in some ways amusing. The man who was operating a private plant in a remarkably efficient manner had no use for purchased power, while his opponent was not a public-utility power salesman, but a representative of an engineering firm whose slogan was "down with the isolated plant."

But why is it always necessary to go from the one extreme to the other? I'll venture the assertion that a system of combination operation, involving the purchase of a portion of the power requirements and the home generation of power from the steam needed for heating, etc., would give a better over-all economy in the plant operated by the isolated plant enthusiast. And I'll further venture the assertion that in a good percentage of the isolated plants scrapped by the engineering firm, a similar system could have been worked out with a greater economy and a greater reliability than has resulted with their plan.

The writer, with the company's chief engineer, worked out such a plan for a total annual current consumption of over 12 million kilowatt-hours, in which the demand for heating steam was such it was most economical to home-generate something over half of the total current. The rest of the power needed is bought from the high-tension lines of the public utility and changed to low-tension direct current by conversion equipment running in parallel with the company's engine-generators. The public utility, after some hesitation, granted a reduction in demand during six months of the heating season, making this maximum demand equal to the non-heating season minimum, and the winter minimum two-thirds of the summer minimum.

Under this plan the engines are run to supply whatever heating steam is needed. The remainder of the power requirement is supplied on the conversion equipment. As power requirements change or as temperature conditions change to increase or decrease the amount of exhaust required to maintain a small positive pressure in the heating mains, the load can be shifted one way or the other. The operators watch the total load meters, the exhaust main gage and the maximum demand meter, and vary the load accordingly.

The operators are familiar with the rates charged by the public utility and with the method of figuring the bill. When a sudden and temporary increase in load comes along, such as a brief clouding-over at a time when the load is already high, they watch the purchased-power load and take up an excessive peak on the engines. This holds the maximum demand fairly level and reduces the purchased power bill by increasing the average load factor. They are trained to know just how far they should go in the direction of throwing peak loads on the engines (which results in blowing some exhaust steam to waste) in order to keep the maximum demand down to a fair level.

This kind of operation results not only in efficiency and a good heat-balance, but in real dollars-and-cents economy. And it has the further advantage of giving two independent sources of power supply, either of which is entirely sufficient to take care of the full load. If the private plant goes down, the conversion equipment takes over the whole load. If the entire public-utility system goes dead, the load is soon shifted over to the engine-generators.

Undoubtedly, this plant will eventually scrap its engines and buy all its current. But that will come, I anticipate, only when the public utility itself will furnish heating steam to this plant at a price considerably below the present cost of making it in the isolated boiler plant. When the public utilities get into the wider use of extra-high-pressure steam and then exhaust some of their turbines into heating mains at 100 or 125 lb. pressure and pipe this steam through the business districts for supply to office and manufacturing buildings, then and then only will they be in a position to supersede all the isolated plants, and do it with mutual benefit to themselves and to their customers.

There is no doubt that the over-enthusiasm of some public-utility power salesman often leaves a permanent bad taste in the mouths of some of their over-sold customers. The proprietor of a fairly large dry-cleaning plant had a grudge against the utility salesman who persuaded him to scrap his engines and buy his power. This proprietor was astounded at the size of his power bills. He wasn't making the savings that had been pictured. When he investigated, he found that about four o'clock every afternoon, when his load was already heavy, a certain cleaning process required the use of an additional large motor for about an hour. This ran his maximum demand so high that his demand charges were out of all reasonable proportion to the amount of current consumed. With this low average load-factor, his average cost per kilowatt-hour was excessive. He found it impossible to avoid this one-hour peak, and finally he obtained a release from his public utility contract and installed a 150-kw. Diesel engine.

An example of the faulty conclusions to which some of these enthusiasts can be led was given by a salesman who closed a big contract with a paper mill for the supply of all its current. The proposition involved scrapping all steam equipment and spending over a half million dollars for substation, motor drives, etc. This salesman immediately concluded that for a paper mill to do anything but buy all its power was the height of folly.

All that was required to show why the mill was willing to buy all its power was just one brief trip through the mill. Steam engines were scattered in dark, dingy, out-of-the-way corners all over the place. They must have been operating for at least 50 years, and they were in a terrible condition. Here was a plant where a combination operation plan would have worked out wonderfully, a steady 24-hour demand for low-pressure steam, with power requirements in excess of corresponding steam needs. This excess could have been bought at a high load-factor and a bleeder turbine or high back-pressure engines used for making the bulk of the power with the steam needed for process work at a low pressure.

And many office-building and manufacturing plant loads are secured by the public utility in a similar fashion—the private plant has become so obsolete that any change at all would be a change for the better. In many of these cases combination operation offers the real solution to the power and heat problem.

North Glenside, Pa. W. J. RISLEY, JR.

New and Improved Equipment

Lickert-Reedy Soot Blower

With a view to providing a soot blower suitable for use in any section of the boiler, including the hottest zone in the first pass, and to reducing the maintenance by withdrawing the elements from the boiler when not in use, the soot blower (known as the Lickert-Reedy) shown in the illustration has been brought out by William J. Lickert, Hamilton, Ohio.

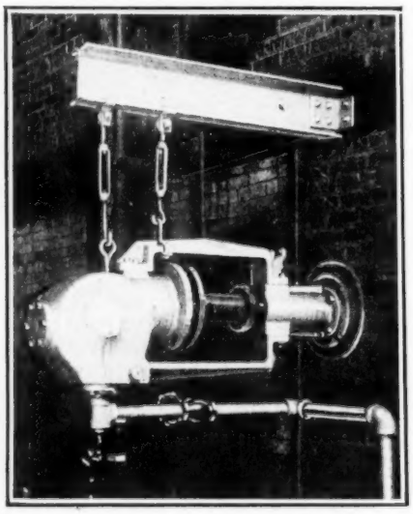


Fig. 1—Soot blower installed on boiler setting

Fig. 1 shows the method of installing the unit on the side of a boiler setting, and Fig. 2 shows the element extended or in the blowing position. The telescopic principle of the element, as will be clear from a study of Fig. 2, permits the element to be run in for operation and withdrawn when the operation of blowing is over. The end of the element is closed, and this acts as a piston to force the element across the furnace when the steam is admitted. A series of nozzles, about 6 to the section, are located in rows along the element.

After the blowing operation is completed, the element is withdrawn from the heat zone by means of an internal chain working over an internal drum which in turn is operated by means of the crank and gearing shown. The elements are fitted with a capstan head rotating in a packed gland, permitting a complete rotation of the element while in operation.

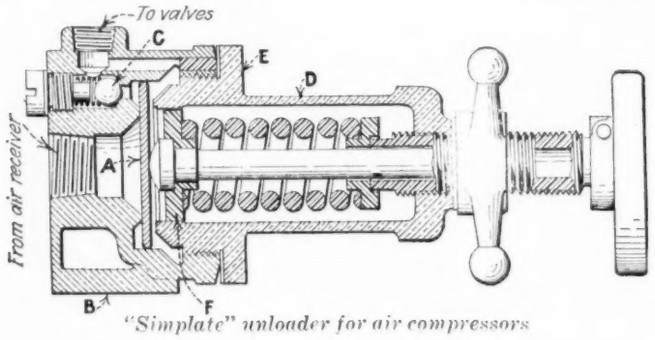
Among the advantages claimed for this design of unit are: Adaptability for use in any section of the boiler, including the hottest zones in the first pass; reduction in maintenance charges owing to the element being outside of the furnace proper when not in use and therefore not subjected to the direct heat of the furnace; permits replacement of boiler tubes without dismantling any elements; removal of entire unit for replacement or repair without taking the boiler out of service.

The blower is manufactured and distributed by Long-Reach Soot Blower Co., 725 Ridgelawn Ave., Hamilton, Ohio.

Chicago Pneumatic "Simplate" Unloader for Air Compressors

Air compressors made by the Chicago Pneumatic Tool Co., New York City, are now being equipped with an improved simplate differential unloader.

The valve proper *A* is a single plate of stainless steel ground to a flat surface and also to fit in the cap *B* with a few thousandths clearance. The edge of the plate is well rounded to prevent its sticking as a result of cocking in the seat. The cap also contains a ball check valve *C* held against the seat by an adjustable spring. The connections by which the unloader is attached to the compressor are on the cap *B* so that the device can be dismantled for examination or cleaning without disturbing the piping or other valves. With an unloading pressure of 100 lb. per sq.in. and a reloading pressure of 95 lb., the device operates as follows: As the air pressure rises to 100 lb., the pressure on the upper side of the valve plate *A* overbalances that of the spring and the air escapes past the seat into the annular space around the outer edge of the disk *A*. Because of the close fit of the disk on the cap and the presence of the ball check valve, the air cannot escape readily and a pressure is built up which, acting upon the surface of the disk, balances the pressure of the spring and moves it down against the seat in the body *E*. The ball check valve *C* is then exposed to full receiver pressure and immediately moves off its seat and uncovers a ¼-in. opening allowing the air to pass through to the unloading inlet valves.



"Simplate" unloader for air compressors

Upon a drop of receiver pressure to 95 lb., the pressure of the spring balances the air pressure and causes it to permit leakage past the lower seat into the space around the stem. This leakage is restricted slightly by the upper spring holder *F*, which is a close fit in the body *E*, and a slight overbalancing pressure is built up, which causes the disk *A* to return to the upper seat.

The unloader is built for standard pressures from 50 to 125 lb. for low-pressure work, and for high-pressure work up to 500 lb. per square inch.

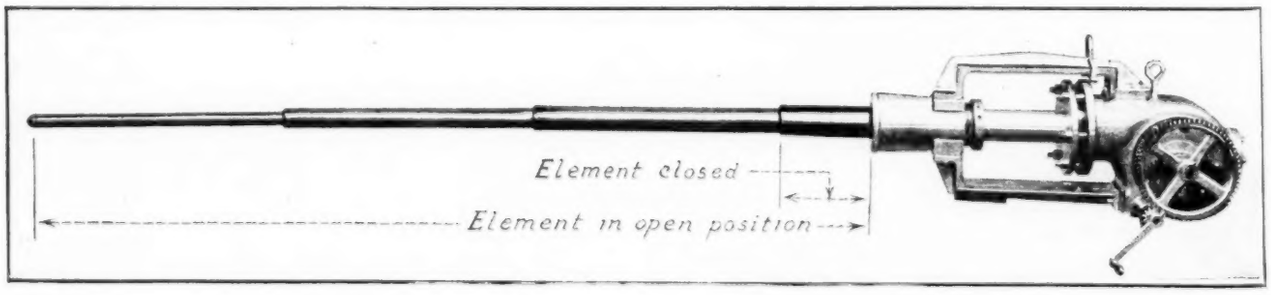


Fig. 2—Telescopic element in position for blowing tubes

A.S.M.E. Regional Meeting Held at Kansas City

POWER and fuel played a leading rôle in the three-day regional meeting held at Hotel Baltimore from April 4 to 6 by the Kansas City Section of the American Society of Mechanical Engineers. The program was diversified as sessions had been arranged under the auspices of the various technical divisions of the Society, such as petroleum, management, power and fuel. Besides, a full session was devoted to education and training for the industries and other sessions sponsored by the local section dealing with a five-year program of industrial development for the city, and problems of local interest relating to flour mills, grain elevators and applications of machinery as applied to agriculture. As two afternoons were given up to the inspection of plants of interest and to an automobile tour of the city, it was necessary to hold simultaneous meetings. In this way the interests of all were served and each had a choice of subjects, according to his preference.

As is usual at regional meetings, the Council was present and went into executive session. The attendance was representative of the middle section of the country, west of the Mississippi, with a sprinkling of visitors from Chicago and the East, and student delegations from the Universities of Missouri, Kansas and Nebraska. Registration totaled 385.

Social Functions

That Kansas City is hospitable and knows how to entertain was demonstrated thoroughly by the local section. The features were a dinner dance Monday evening in honor of D. S. Kimball, chairman of the Council; on Tuesday a luncheon at the Kansas City Engineers Club to the visiting delegation by the six engineering organizations of the city, and in the evening a banquet at which W. L. Abbott, past-president of the Society, was the guest of honor. At these functions F. S. Dewey, chairman of the local section, presided.

As readers will be interested chiefly in the power and fuel sessions, this report will be limited to a brief summary of the proceedings therein. Most of the papers in these two sessions will be presented later in fuller detail.

Under the auspices of the Power Division of the Society, with Prof. A. G. Christie presiding, the first paper of the power session was an abbreviated summary on the "Treatment of Feed Water for Industrial and Power Plant Boilers," by S. T. Powell, chemical engineer, of Baltimore. Without attempting to designate the type of system, the author indicated the general adaptability of the more important methods of treatment. For removing suspended and scale-forming solids, plain subsidence, filters, chemical and Zeolite softeners were considered. Some attention was given to evaporators, deaërators, continuous blow-down systems, electrolytic scale-prevention appliances, internal treatment and the conditions responsible for priming and foaming. Reference was made to the comprehensive study of this general subject now being carried on by six of the major engineering organizations of the country interested directly or indirectly in the various phases of this work. Discussion was limited to brief comment on sodium aluminate as an adjunct to the usual softening reagents and as an aid in internal treatment.

A HIGH-PRESSURE unit, consisting of a 1,400-pound boiler supplying a 10,000-kilowatt turbine that will exhaust to the main station header, is contemplated for the Northeast Station in Kansas City.

In a comprehensive paper on "Present Tendencies of Steam Station Design[1]." Vern E. Alden, engineer in the mechanical division of Stone & Webster, Inc., summarized the underlying motives that have spurred on power-station engineers to improved designs that in the last fourteen years have lessened maintenance and the amount of labor required and reduced the coal consumption per kilowatt-hour from 1.6 to 1 lb. Picturing the typical steam generating station of 1913, as a basis, he traced the changes that have taken place in steam pressure and temperature, heating feed water by economizers and stage bleeding, use of air preheaters, furnace design, improved methods of burning coal, auxiliary drive and increased size of equipment. Looking into the future, the author predicted higher steam temperatures, increasing use of pulverized fuel and larger turbines and boilers, although for the next few years he believed that the most attractive possibilities in station design would be along the lines of consolidation of the gains already made, simplification of the new designs and adaptations of certain tendencies in design that would permit of reductions in investment with but slight increase in coal consumption per unit of output.

In written discussion E. H. Tenney thought it a fitting time to take stock. He referred enthusiastically to the benefits to be derived from air preheating and from the turbulent mixing in powdered-coal burners that had been made possible by the introduction of the forced-draft fan. The advantages of the unit mill were enumerated and some consideration was given to the effect of water walls and screens. It was his belief that Mr. Alden had not given sufficient credit to the advance that had been made in the efficiency of burning Western coals.

As part of a symposium on steam-power development in the Middle West, following Mr. Alden's paper, J. A. Keeth reviewed the developments that have taken place in Northeast Station, Kansas City, to keep it in line with the progress traced by the foregoing speaker, such as the introduction of steam extraction and air preheaters, the substitution of steam-jet air pumps for hydraulic pumps, the installation of unit pulverizers for one boiler and the contemplation of a 1,400-lb. boiler, with a 10,000-kw. high-pressure turbine exhausting to the main steam header of the station.

Midwest Power Stations Discussed

F. S. Collings, of Sargent & Lundy, Chicago, had been asked to follow with an outline of the more outstanding points of interest associated with the design of the modern power station in the Middle West. He did this admirably and included a series of charts summarizing earlier investigations that he had made on the economies of high-pressure steam. In the final analysis in which investment and operating charges were balanced against thermal efficiency, it became apparent that a working pressure of 600 lb. offered the best return on the invested dollar at this time. These curves and his discussion on other points will appear in an early issue.

Charles F. Turner reviewed the fuel-burning problems that have been encountered in the Omaha station of the Nebraska Power Co. E. H. Tenney made brief mention of the powdered-coal installations at Ashley Street and Cahokia stations in St. Louis, compared the burning of Midwestern and Eastern coals in powdered form, referred to new side-wall construction in which the water tubes are recessed in the refractory and summarized the relative advantages of the unit mill plan vs. the central storage system.

K. M. Irwin, of the Sioux City Gas & Electric Co., recounted experiences with different kinds of Western coals, running high in ash and moisture, at the Big Sioux Station, a powdered-coal plant of the bin-and-feeder type. Aside from furnace maintenance troubles such as the washing out of the front wall, the installation, he said, had given excellent satisfaction; boiler efficiencies had averaged for a week at a time 84.6 per cent.

C. S. Tomlinson, of the Kansas Gas

[1] Abstracted in *Power* April 12, 1927.

& Electric Co., pointed out the problems encountered in central-station location and design in the Middle West owing to the peculiarities existing, such as the scarcity of a suitable all-year water supply, the need for spray ponds, the inferior grades of coal and the scattered load. He enlarged upon spray-pond practice and the cost of pumping and outlined current practice and experiences in the burning of oil, gas and coal, the last-named fuel being Cherokee slack, which had been burned on underfeed stokers.

Low Temperature Distillation

At the fuels session, with J. Van Brunt presiding, the lead-off paper was on "Low Temperature Distillation," by Walter Runge, of the International Combustion Engineering Corporation, of New York. Briefly, the author described three typical processes using the rotary kiln, the concentric-drum type of retort and the horizontal, stationary retort. Heating value of the semi-coke produced and the price at which the coke should sell were points considered, and conservative estimates were made of production costs and profits. These data will be given elsewhere in these columns in an abstract of the paper. Aside from the original manuscript, slides were presented of microphotographs showing changes in the structure of the coal as it passes through the process; also views of a German plant for the production of domestic coke and photographic reproductions of the two-retort vertical Milwaukee installation with comments on its construction and operation.

In the discussion of the paper there were inquiries on the igniting qualities of the coke and the comparative volatile and moisture contents of the original coal and the coke produced. It was stated that in coal from western Pennsylvania that had been used at Milwaukee, the volatile had been reduced from 33 per cent in the coal to about 10 per cent in the coke and the moisture to 1½ per cent. With too much volatile remaining, the coke would be too plastic to handle and not enough by-products would be recovered. Demonstrations with funnels showed the ease with which the coke flows through a small opening compared to samples of powdered coal.

Prof. A. G. Christie was not optimistic over the possibilities of low-temperature distillation, particularly from the viewpoint of possible profits. For the benefit of the public generally, he issued a warning to keep away from promotional schemes involving so-called paper processes, as many of them did not work out satisfactorily in commercial applications. In his opinion prospects are perhaps more favorable for plants situated near the mine from which the gas will be turned into natural-gas mains and the coke shipped to the points of use.

"Burning of Midwestern Fuels" was a subject ably handled by E. L. McDonald, efficiency engineer of the Kansas City Power & Light Co. Using slides he located the coal fields of the Midwest section of the country and the active mining areas. Outstanding characteristics of the coals from Iowa, Kansas, Missouri, Oklahoma and Illinois were given and comparisons made of their combustion on forced-draft chain-grate stokers in the Northeast Station of the company. Charts were presented to show the relative air pressures required in the different zones of the stoker, the fusing temperatures of the ash and the relative efficiencies and capacities obtained with these coals. The author commented on the character of the flame, the furnace temperatures, the effect of adding moisture in the burning of these fuels and slagging problems encountered. Difficulties in the ignition of these coals, so high in ash and moisture, he said, have been relieved by the installation of air preheaters. A theoretical gain of 1.8 per cent has grown in practice to 4 or 5 per cent, owing to the better ignition and more complete burning of the coal.

Factors in Industrial Furnace Design

Victor J. Azbe, consulting engineer, of St. Louis, gave an interesting paper dealing with "Industrial Furnace Fundamentals," in which underlying reasons were given why it is so difficult to obtain high efficiencies in many furnaces and kilns. High working temperature levels make the losses from excess air and radiation much more serious than in the case of the steam boiler. Further, the problems of long and short flame, reducing or oxidizing atmospheres, counter-current heat flow, heat transfer by direct contact on through muffles, recirculation of the gases, retarded combustion, proper gas flow, high-temperature insulation and maintenance of refractories are such that even the best combustion engineers find it difficult to cope with them. Efficiencies as low as 10 per cent, losses of 40 per cent due to excess air alone, and flue-gas temperatures of 1,800 deg. F., with no effort made to recover the waste heat by means of recuperators, gave some indication of existing conditions.

In the final paper of the session, dealing with the "Production and Distribution of Fuel," C. M. Young, professor of mining engineering at the University of Kansas, emphasized the dependence of the mechanical engineer on mineral fuels and the importance of the coal-mining industry as a field for the mechanical and electrical engineer. Notwithstanding unfriendly reception by the miners, mechanization of the mining industry, he said, is proceeding rapidly. Further progress in mechanization should be along such lines as to replace the maximum of human labor, and probably the most favorable field for effort is in the loading of coal in the mine. Introductory to this conclusion Professor Young first classified coals, gave the output of different districts, an outline of the routes of distribution by rail and water, the shift in output owing largely to labor conditions, and traced the gradual application of machinery to production and distribution. Slides were thrown upon the screen, to illustrate methods of mining, typical cutting and loading machines, electric locomotives and belt and shaking conveyors for haulage, types of hoist and other equipment.

Back of the mechanicalization program favored by the author, was the thought that labor accounts for 70 per cent of the total cost of coal production. Substituting machinery for a part of the man labor now employed, offers a promising field for the reduction of the cost of coal. This in turn would reduce the cost of power and make possible a wider application of mechanical energy to all sorts of uses.

The Variation of Size in Clay and Silica Refractories

The American Refractories Institute has published a bulletin by S. M. Phelps and H. F. Robertson, pointing out the difficulties involved in measuring the dimensions of firebrick and giving data on dimensional studies of 55 lots of various types of brick, 50 bricks comprising each lot.

An apparatus was devised in which the brick is measured between two parallel cast-iron plates to the nearest hundredth of an inch. This procedure includes in the dimensions the effect of warpage and swelling and gives an over-all size that is the largest obtainable by any method. Methods that obtain average size by the measurement of a stack of brick often lead to conflicting results.

Samples of brick made by the following processes were measured: Dry pressed, hand made, soft mud, stiff mud, and hand and power re-pressed. Brick were taken from various parts of the kilns representing hard, medium and soft burns. Selections were made by men at the brick plants where the measurements were made.

The following table presents the average results of all the brick measured.

	Length	Width	Thickness
Hand made	9 1/32	4 15/32	2 15/32
Stiff mud	9	4 7/32	2 7/32
Dry press	9 1/16	4 1/32	2 1/16
Average	9 3/32	4 1/32	2 1/16

The user of brick would welcome a standard 9x4½x2½-inch brick true to size, but the practicability of manufacturing such a product is doubtful. The engineer requesting such brick is unfamiliar with the manufacturing problems that would be involved. The variables of manufacturing are many, and some are not within practical control of the producer. Economically, such a requirement would not be feasible at the present time. The best that can be done is the limitation of the variation of size. This is practical because the manufacturer can with proper attention control size variations within certain limits, and within such limits the bricklayer would receive brick that should answer all practical requirements.

The authors recommend as a reasonable requirement that not more than 10 per cent of the brick in a shipment shall vary by more than 1/16 in. in thickness, 1/16 in. in width and ¼ in. in length, from the average size. Such specifications will require careful plant control, but it is believed that they can be met with reasonable care. It is also believed that such specifications should answer the practical requirements of the consumer and thus constitute an equitable limit for the industry.

Present Fuel Situation and Stokers Discussed

New York Engineers Told There Is No Danger of a Coal Shortage nor Reason To Expect an Abnormal Increase in Prices—Stoker Design Shown To Have Kept Pace with Boiler Demands—Spirited Discussion on Relative Merits of Stokers and Powdered Coal

AT THE Metropolitan Section, A.S.M.E., last Wednesday night, R. Dawson Hall, editor of *Coal Age*, analyzed the coal situation and indicated how the buyer might keep an eye on the status of affairs.

Differentiating between the anthracite and the bituminous regions, he pointed out that they usually make contracts at different times. Unless unforeseen occurrences intervene, the anthracite region will continue working without stoppage, barring possible company strikes, until Aug. 31, 1930.

The bituminous region, however, is now in the midst of a suspension, which began April 1, but there is a supply of coal on hand, which is estimated by some to approximate 100,000,000 tons. This is, roughly, a fifth or sixth of all we are likely to use for a year. Moreover, this stock is on hand just before the summer season, when coal is in less demand.

Recalling that the high point of last year's weekly production was over 14,000,000 tons, and that about 70 per cent of the bituminous miners are now working, reckoning both union and non-union men, a potential weekly output of 9,800,000 tons is possible. This is more than was produced for the summer period last year. "It is evident, therefore," said Mr. Hall, "that if the suspension runs along as it is now doing, and does not become more extended, an adequate supply will be assured and it will be safe to let suspension settle itself without interference."

With particular references to New England, which has heretofore been the region most hit, and whose competitive buying has been responsible for high prices during coal shortages, that region is now receiving most of its coal through Hampton Roads and Baltimore. This coal comes from non-union fields.

Mr. Hall illustrated his talk with a number of production charts and explained the statistical service rendered by the U. S. Bureau of Mines and the National Coal Association.

Performance of Modern Under-Feed Stokers

W. C. STRUNK, of the Westinghouse Electric & Manufacturing Co. presented the second paper of the evening, in which he enumerated the various points that must be met by the modern successful stoker and showed how these are being met, in spite of the problems injected by the continually increasing rates of firing. Extremely flat efficiency curves are being obtained at these high ratings, but a point requiring further study is that of reducing the combustible in the refuse at these ratings. Such a reduction would render the curve still flatter. The speaker advised more attention being paid to cutting down air infiltration, pointing out that a loss of 2 per cent in CO_2 from the first pass to the economizer or preheater represents approximately the same loss in efficiency. He believed that caution should be used as to the amount of water-wall surface to be employed with high surface ratings.

Another point which the speaker raised was the importance of the feed being uniform, whether the fuel is wet or dry. Further developments will be necessary along this line before the feeding mechanisms can be called entirely satisfactory.

Mr. Strunk's paper was fully discussed. J. S. BENNETT, of the American Engineering Company, spoke of the Taylor stokers at the Saginaw River Plant, which are running in excess of 500 per cent rating, and predicted that stokers would be built for burning up to 150 lb. of coal per square foot per hour. He showed a slide of the stoker and setting of the new 1,400-lb. boiler which is to go in the Edgar Station, and mentioned briefly the results obtained with the automatic air motors at that station as well as at the Richmond Station in Philadelphia.

F. H. DANIELS, president of the Riley Stoker Corp., was of the opinion that with stokers the averaging operating efficiency is about four points less than the test efficiency, whereas with powdered coal the average operating efficiency is about two points less. This is due to the greater ease in maintaining the air control. Also, with powdered coal the combustible in the ash is about two points lower, although more ash is likely to go up the stack. The losses in banking are not likely to be very much more with stokers than with powdered fuel. In either case the losses are principally due to radiation from the boiler setting. With the stoker this heat is continually replaced during the banking period, whereas with powdered fuel it has to be replaced when the fires are relighted.

Mr. Daniels believed that, as between stokers and powdered coal, no general recommendations could be made. Each case must be solved on its merits, with all factors figured. He did believe, however, that there was considerable saving in installation cost with the unit pulverizer over the bin and feeder system. Furthermore, he was strongly convinced that turbulent mixing burners give the best results.

H. D. SAVAGE, of Combustion Engineering Corp., conceded that stokers and pulverized fuel could be depended upon for about the same efficiency, but that one can obtain greater output with the pulverized fuel. He described the boiler installation at the Kips Bay Heating Station of the New York Steam Co., which has a bin and feeder system, and mentioned that from 350,000 to 400,000 lb. of steam are being produced per hour on a single unit at this station. He believed further that preheated air is better handled with powdered coal for continuous operation at high ratings than with stokers. The longer a boiler can be kept on line the better, and too little consideration is often given to outages on such units.

Why Powdered Coal Was Selected for East River Station

Replying to the question of Chairman Barron as to why powdered coal had been selected for the new East River Station, John Lawrence, of Thomas E. Murray, Inc., explained the space limitations of the property and pointed out that greater capacity per unit of area can be obtained with powdered coal than with stokers. He also claimed lower over-all cost with powdered coal for this particular plant and stated that, at the time the decision was made, he did not believe the stokers had been so highly developed to handle the high ratings demanded. He emphasized the necessity for attaining the highest economic efficiency, irrespective of thermal efficiency and believed that in this particular installation powdered fuel has proven to have the highest economic efficiency.

Mr. Lawrence told further some of the experiences leading up to the development of the fin-type water wall. Following the starting up of the Hell Gate Station, in 1921, considerable difficulty was experienced in maintaining refractories at the high ratings carried. At the end of the year it was found that the expense had amounted to approximately $100,000. This led Mr. Murray to experiment with water walls.

G. L. Knight, of the Brooklyn Edison Co., related some of the experiences with the stokers at the Hudson Avenue Station, and expressed the opinion that high steaming rates and preheated air are doing much to develop and make modern stokers a success. The new stokers at Hudson Avenue are burning 64 lb. of coal per sq.ft. per hr., as against 51 lb. with the old stokers at that station. He emphasized the necessity for close air control and proper distribution at these high rates.

Recent Publications

Die Widerstandsfahigkeit von Dampfkesselwandungen Herausgegeben von der Vereinigung der Grosskesselbesitzer E. V. Mit 176 Textabbildungen. Berlin, Verlag von Julius Springer, 1927.

This treatise on the strength of steam boilers presents the results of extensive investigations conducted at the German Institute for Testing Materials. The volume, the first, is composed of a number of papers containing researches up to 1920.

Non-Technical Chats on Iron and Steel, and Their Application to Modern Industry. By L. A. Verne W. Spring, chief chemist and metallurgist, Crane Co., Chicago; 342 illustrations and diagrams. New and revised edition. Frederick A. Stokes Co., New York City.

"Non-Technical Chats on Iron and Steel" tells the story of this industry from its earliest beginnings in a way that will fascinate the layman yet without losing sight of the technical aspects. Primarily it is a book for metal workers, chemists and students, but members of the engineering professions will also find it entertaining. This revised edition contains thirty chapters and more than three hundred illustrations on points of general interest in the story of iron and steel.

Proceedings of the International Conference on Bituminous Coal. Published by the Carnegie Institute of Technology, Pittsburgh, Pa., 1927. Cloth boards; 6x9 in.; 830 pages; with numerous illustrations and an inserted map showing the coal fields of the United States.

This volume reports in full the proceedings of the International Conference on Bituminous Coal held at the Carnegie Institute of Technology, Nov. 15-18, 1926. It gives the full text of 44 papers read at the conference, with the discussion, on a wide variety of subjects covering the classification, preparation and utilization of fuel, especially coal. Much space is devoted to the treatment of coal with the recovery of byproducts. The volume should be valuable to forward-looking engineers in the field of fuel utilization. In the preface President Baker, of the Carnegie Institute of Technology, announces that the success of the first conference was so encouraging that a second international congress dealing with this subject will be held at the Carnegie Institute in November, 1928.

Descriptive Bibliography on Oil and Fluid Flow and Heat Transfer in Pipes. Technical Series Bulletin, Missouri School of Mines, Rolla, Mo., By Joe B. Butler, Associate Professor of Civil Engineering.

This bulletin of 62 pages lists and describes 370 references to published articles and books. The references are arranged chronologically as to year of publication, are fully cross-referenced, and are indexed as to subject, author, and periodical. A short article on the flow of oil in pipes gives formulas, data and procedure in solving problems.

All articles with data on friction loss and heat transfer in oil flow are included. Of the articles on flow and heat transfer in pipes of water, air, steam, and gases, only those with data pertaining to fluids in general are listed. Articles on critical velocity, viscosity and viscosimetry are included if they have applications to oil or fluid flow in pipes.

In 1914 Stanton and Pannell experimentally established for fluid flow in pipes that the friction factor in the ordinary hydraulic formulas is a function of the ratio of the inside diameter of the pipe times the average velocity of flow times the specific gravity of the fluid divided by the absolute viscosity of the fluid. Curves showing this relation over both the streamline and turbulent régimes of flow are plotted from experimental data on water, air, oil and steam. The author lists 51 references having data on curves applicable to oil over both régimes of flow.

Copies of this bulletin may be obtained by writing to the Librarian of the Missouri School of Mines, or to the author.

Water Power Resources of Canada. Department of the Interior, Canada, Dominion Water Power and Reclamation Service.

The Dominion Water Power and Reclamation Service of the Department of the Interior of Canada has recently issued the annual review of the water-power resources of Canada, developed and undeveloped as at March 1, 1927, according to the most recent information available. This bulletin includes sections dealing with current progress and development, the use of water-power in the central electric stations and for the pulp and paper and other leading industries, the coal equivalent of developed water-power, and estimates of the developed and undeveloped water-power in each province.

By the end of the year 1926 Canada's hydraulic installation reached a total of 4,556,266 hp., of which 265,838 hp. was installed during that year. While the addition for 1926 was substantial, it falls far short of indicating actual constructional activities, as projects under way, a number of which are nearing completion, will ultimately add to the Dominion's total more than 1,700,000 hp., while others in active prospect indicate a further addition of 1,000,000 hp. As the capital investment due to these developments under construction and in prospect is estimated at approximately $270,000,000 regardless of the extra capital required in the application of their power output some idea is gained of the stimulus which will be given industry by their completion.

Copies of this bulletin may be obtained free of charge on application to the Director of the Dominion Water Power and Reclamation Service, Ottawa, Canada.

Lectures on Engineering Practice, 1925-1926. Edited by A. G. Christie, acting dean of the Faculty of Engineering, The Johns Hopkins University. Published by the School of Engineering of The Johns Hopkins University. Printed by The Johns Hopkins Press, Baltimore, Md., 1927.

Two lectures on engineering practice delivered before the School of Engineering of The Johns Hopkins University, during the last academic year, constitute this thin but very inviting volume. As a special feature of a general plan for improving undergraduate instruction in the broader aspects of the methods and problems of engineering practice these papers will be of special benefit to the student and younger men of the profession.

"How Long Shall We Live?" by C. F. Hirshfeld, chief of the research department of the Detroit Edison Co., is skillfully built up on the question of the length of time that the human race will inhabit the earth. This seemingly abstract problem gives here an added color and light to the practical challenge: what is the business of the engineer, how may he best regard it, and how may he best prepare for it.

"I should like to urge upon you young engineers, who are just starting life, two things: First, that you make economic considerations and not sentiment the basis of your engineering decisions; and second, that as members of the respective communities in which you may happen to work and live, you do what you can to make others use the same yard stick instead of morbid sentimentalism." This, to quote only one expression of Mr. Hirshfeld's message.

"Electron Currents Through a Vacuum and Through Gaseous Atmospheres" is the contribution of C. W. Hewlett, research engineer, General Electric Co., Schenectady, N. Y.

Carbon Brushes and Brush Shunts. There has just been issued a bulletin, "Simplified Practice Recommendation No. 56" by the United States Department of Commerce on the recent recommendations for the simplifying of dimensions of carbon brushes and brush shunts. These recommendations in a large degree are those previously adopted by the Electric Power Club. No attempt has been made to eliminate any of the sizes now in use, but this matter is to be considered at the first revision conference to be held during this year. Copies of the bulletin may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 5 cents.

School of Mines and Metallurgy of the University of Missouri, Fifty-sixth Annual Catalog. Rolla, Missouri, 1927.

This is a general report of the activities of the School of Mines and Metallurgy of the University of Missouri.

News in the Field of Power

Standards Committee Rules River Rating Methods

A national agreement on the methods of rating the water power of rivers has been tentatively reached according to an announcement by the American Engineering Standards Committee. As the question is one of international importance, the co-operation of other countries is being sought before any final decision is made.

Another question that has been given much consideration by that committee relates to the best way of expressing the fluctuations in capacity of a water-power site caused by variations in stream flow. A 100,000-kw. steam plant may be operated at full capacity as long as coal or oil is fed under the boilers; but a 100,000-kw. generator in a hydro-electric plant will operate at full capacity only as long as there is sufficient water to run the wheels. In some of the most modern plants the water supply is sufficient to operate the whole plant during only two months in the year. The committee has had to consider how best to present a picture of the effect of the variable quantity of stream flow on the capacity of the site.

Kilowatt as Unit for Sites

After giving these and many other questions consideration for over a year, the committee has tentatively decided that the kilowatt should be used instead of the horsepower as the unit for expressing the capacity of water-power sites; that the capacity shown should express the theoretical potential power without deductions for the losses, which are sure to occur in water-wheels, generators, transformers, etc.; and that the capacity should be stated for two rates of flow—one called the 90 per cent-of-time flow corresponding to a flow available 90 per cent of the time, and the other called the 50 per cent-of-time flow corresponding to the flow available one-half of the time.

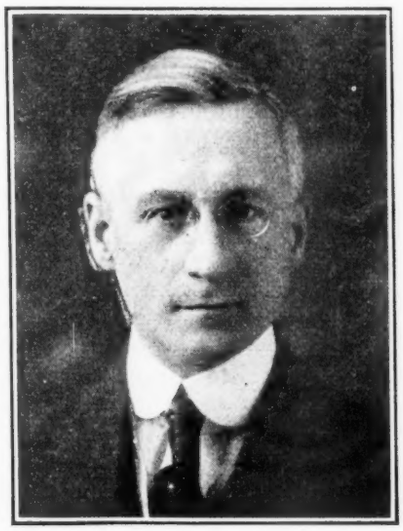
It is the desire of the committee to have these tentative rules discussed fully and frankly by everyone interested in hydraulic development in this country to the end that they may be so modified that as finally adopted they will represent the best American opinion. This problem is also being taken up internationally through the International Electrotechnical Commission.

Yosemite Power Co. Applies for Tuolumne Project

The Yosemite Power Co., San Francisco, has applied to the Federal Power Commission for a license covering a project on the South and Middle Forks of the Tuolumne River. The plan of development embraces the construction of two reservoirs of 65,000 acre-ft. capacity, three power houses and the necessary transmission lines and conduits. It is planned to install equipment sufficient to develop 51,000 hp.

Nicholas Stahl Resigns Post at Narragansett Electric

Nicholas Stahl has resigned his position as superintendent of generation with the Narragansett Electric Lighting Co., of Providence, R. I., and, according to advices, will assume the duties of vice-president in charge of operation of the United Public Service Co., with headquarters at 100 West Monroe St., Chicago, Ill., May 1.



Nicholas Stahl

The United Public Service Co. is a new holding company operating electric, gas and ice plants in Ohio, Indiana, Illinois, Tennessee, Mississippi, Louisiana, Texas, Arkansas, North Dakota and South Dakota.

Prior to 1918, in which year he became associated with the Narragansett Electric Lighting Co. as superintendent of generation, succeeding in that position Martin W. Kern, Mr. Stahl was connected with the Westinghouse Electric & Manufacturing Co. A conspicuous figure in the field of electric central-station engineering, Mr. Stahl has served influentially in a number of important capacities, among them as chairman of the Prime Movers Committee of the National Electric Light Association.

Shoal Rights, Federal, State's, Up for Study

In response to memorials from several state legislatures the Department of Justice is studying the legal problem of the relationship of federal and state rights in connection with the federal government's Muscle Shoals project. The published statement that this study is being made at the request of President Coolidge is erroneous. The position of the state is summarized briefly as follows:

"The state recognizes every legal and equitable right of the national government in and to its investment at Muscle Shoals for both navigation and war purposes, but should the government depart from the manufacture of war munitions and seek to operate the power plant for the manufacture of electric power for commercial purposes, or to lease the property for the primary purpose or profit, the state must require such terms or revenues for the state as may be determined to be just."

Symposium Plans Feature Annual Welding Meeting

Various manufacturers leading in the field of arc welding production will take part in a symposium of research activities, which have been carried on during the past three years, as an outstanding feature of the eighth annual meeting of the American Welding Society to take place at 33 West 39th St., New York City, April 27 to 29. This round-table discussion will be held as the first technical session the morning of April 28; it will be followed in the afternoon by a similar symposium of production welding.

Two committee sittings will occupy the morning of the first day, when the gas welding committee and the electric arc welding committee will meet. Following the symposiums on Thursday a dinner dance is scheduled for the evening, while Wednesday's entertainment program includes for the registered lady visitors a luncheon at the Hotel Commodore and a matinee party at Roxy's Theatre.

The board of directors will meet during the morning of April 29. Business of the annual meeting will conclude with that of the joint pressure vessel committee in the afternoon.

Ottawa River Project Meets Snag in Controversy

The controversy in Canadian Parliamentary circles over claims to the important Carillon water power site on the Ottawa River was temporarily concluded on April 7, when the bill to renew the Georgian Bay Canal charter was killed by the Railways and Canals Committee of the House of Commons.

The bill, if carried, would have empowered the Georgian Bay Canal Co. to construct a ship canal from Georgian Bay to the St. Lawrence River, and would have given the company all the subsidiary power rights along the proposed canal route, including the Carillon site. It has been estimated that the

water falls on the Ottawa River are capable of producing 1,000,000 hp.

It now rests with the Dominion Government and the provinces of Ontario and Quebec to decide who will develop the Carillon site. It is possible that the federal government may decide to form a Federal Hydro Commission for the purpose of developing Ottawa River power.

Papers and Trips To Feature A.I.E.E. Bethlehem Meeting

A regional meeting for the middle eastern district of the American Institute of Electrical Engineers will open at Bethlehem, Pa., April 21 and close with a number of inspection trips Saturday, April 23. Hotel Bethlehem will be the headquarters for the meeting.

Four technical sessions are scheduled, two the first day, Thursday, and two Friday, with a total of ten papers presented on important subjects of current interest. Introductory remarks by A. G. Pierce, national vice-president, a paper entitled "Oil Circuit Breaker Development," by R. M. Spurck, General Electric Co., and "reducing Losses in Electric Systems," by J. B. Moorehouse, Central Illinois Public Service Co., will occupy the attention of the members the first session. In the afternoon, at the Alumni Memorial Bldg., Lehigh University, "Improvements in Large Induction Motors," by D. F. Alexander, Westinghouse Electric & Manufacturing Co.; "Intercommunication in Industrial Plants," by L. A. Cutshall, Automatic Electric, Inc., and "The Mercury Arc Rectifier," by O. K. Marti and Haro d'Winograd, both of the American Brown Boveri Electric Corp., will be given consideration.

An informal dinner is scheduled for the evening with an address by M. H. Aylesworth, president of the National Broadcasting Co., to be followed by a dance for the ladies.

Papers and Trips

Four papers and a report will conclude the technical business Friday: "Application of Electricity in Cement Mills," W. E. North, Coplay Cement Manufacturing Co.; "Application of Electric Power to Anthracite Mining," E. B. Wagner, Lehigh Valley Coal Co.; "Recent Developments in Electric Drive for Rolling Mills," L. A. Umansky, General Electric Co.; "Lightning and Its Effects on Transmission Lines," J. H. Cox, Westinghouse Electric & Manufacturing Co., and "Committee Report on Voltage Standardization," B. G. Jamieson, Commonwealth Edison Co. Reminiscences of Heaviside and Steinmetz will be the topic of a talk in the evening by Dr. Ernst J. Berg, Union College, at Alumni Memorial Bldg., Lehigh University.

A number of inspection visits and tours to utility plants and industrial works will be made Saturday. Among these already planned and deserving of special note are: Ingersoll-Rand Co., Phillipsburg, N. J.; International Motor Co., Allentown, Pa.; Bethlehem Steel Co., and the Roller-Smith Co., at Bethlehem; Lehigh Coal & Navigation Co., Lansford, Pa.; Penna. Power & Light Co., Allentown, Pa.

Revision of Refrigeration Code Is Announced

In announcing plans for a revision of the refrigeration safety code, F. E. Matthews, chairman of the American Engineering Standards Committee sectional committee, reported that between six and seven thousand copies of the code in its various stages of development have been distributed to interested parties throughout the United States, with the result that a number of states and municipalities have adopted the Code Committee's recommendation, in whole or in part, as has best fitted their requirements.

The code in its present form was officially adopted by the American Society of Refrigerating Engineers in December, 1925. Constructive suggestions for the improvement of the code will be particularly appreciated at the present time and while the code is undergoing revision.

A limited number of copies of the proposed code are still available and may be had by addressing the American Engineering Standards Committee, 29 West 39th Street, New York City, or the American Society of Refrigerating Engineers, 35 Warren Street, New York City, Owing to probably slight revisions and additions to the code there will be no further copies of the present draft available after the present supply has been exhausted.

Metropolitan A.S.M.E. Prize for Students' Contributions

The Metropolitan Section of the American Society of Mechanical Engineers has announced the establishment of the Metropolitan Section Prize, to be awarded annually to a student associate in the Metropolitan Section who shall have presented the most meritorious paper on a subject of interest to engineers, without restriction as to the nature of the treatment, whether technical, administrative, economic or otherwise.

The prize will consist of the initiation fee and one year's dues to be paid into the treasury of the society on behalf of the winner when his application for the junior grade of membership shall have been accepted. If the winner is an associate of a student branch and at the same time a junior member of the society he will receive a prize consisting of the payment of two years' dues.

The papers considered shall be submitted during the year ending June 30. For further particulars as to the preparation of manuscipt and other details the Assistant Secretary in Charge of Student Branches, A.S.M.E., 29 West 39th St., New York City, should be addressed.

Movie of Carborundum Story Now Available

The refractory division of the Carborundum Co., at Perth Amboy, N. J., has completed a motion picture of the story of the manufacture and uses of carborundum refractories. The film begins with an episode showing Dr. E. G. Acheson reproducing his original experiment in which the first carborundum—the basis of all carborundum refractories—was created. The film then shows how carborundum is produced today in the electric furnaces at Niagara Falls. Then the audience is shown the refractory plant at Perth Amboy, and in detail the various processes of manufacturing carborundum refractory products.

This film can be secured by applying to the Carborundum Company, Refractory Division, Perth Amboy, N. J. Arrangements can be made for a speaker to present the film.

South America Needs Capital for Trade Growth—Hoover

"Last year our imports from and exports to Latin America were near a billion dollars each way with the balance somewhat against us," according to Secretary of Commerce Hoover, speaking at a dinner to ambassadors and representatives of Latin American Republics, held in New York City, April 2. "We buy more goods from some of our Latin American neighbors than we sell to them; to others we sell more goods than we buy from them. Complaint in either case from the buyer or the seller has no economic foundation. The great web of international trade is no longer a simple exchange between two countries, it flows into a great common pool which finds its own proper balance. If we buy from the Argentine less goods than we sell to it, we are with the other hand buying similar amounts of goods from Europe which enables Europe in turn to purchase more from the Argentine.

"Our Latin American neighbors are today largely dependent, each of them in their trade, upon the export of two or three predominant commodities. They possess vast natural resources which contribute an increasing and more secure prosperity. We ourselves have passed through this same stage and we found that this dependence upon a few specialized industries and exports brought us great hardships with every shift of world demand.

"The solution of this greater diversity lies in the development of those resources. For this purpose our neighbors to the south need the temporary service of imported capital for some years to come. Without it their progress must be slowed and the advancing standards of living of their people halted." The exchange of students for the study of mutual ideals and the character of governments was endorsed toward this.

Week of Strike Cuts Coal Output 4,500,000 Tons

Preliminary figures on bituminous coal for the week ending April 9, the first full week of the strike in the unionized soft coal fields, indicate an output of approximately 8,500,000 tons, the Secretary of Commerce, Herbert Hoover, stated orally on April 12.

The production, Mr. Hoover said, compared with approximately 13,000,000 tons brought above ground during the last weekly period of full operation. Mr. Hoover added that before the cessation of work, which has occurred in

the largest of the union bituminous fields, the probable output from the non-union mines and those unionized remaining in operation was 9,000,000 tons weekly. No local shortages are likely; with output at 70 per cent and the strike area decreasing there is no cause, whatever, for alarm.

Boiler Production Drops Under Last Year

In line with the general curtailment in the nation's industrial production reported for the month of March, the boiler-manufacturing plants of the country reported a drop in productive activities of 12.3 per cent under February, and a drop of 4.7 per cent under March of last year. General industrial production was 4.9 per cent under February and 3.5 per cent under March of last year. Also, in spite of the fact that there were three and a third more working days in March than in February, the actual production of boilers during March was about 0.6 per cent under that of February. Such are the operations of the boiler manufacturing plants of the country as indicated by monthly electrical energy consumption of more than 50 of these plants scattered throughout the nation.

March was the first month since October, 1926, during which the production of the boiler-manufacturing plants was below the production for the same month of the year previous. Industry appears to have reached its peak of production last December, since which time the monthly production has rapidly declined, the March production being about 20 per cent under that of December.

There is reason to believe, however, that the curtailment in boiler production witnessed during March was of a temporary nature. The volume of heavy construction contracts let during the first three months of this year totaled $630,448,000 as against $600,999,000 for the same period of 1926, an increase of thirty million dollars, or about 5 per cent. This record volume of new heavy construction should be reflected in increased operations by the boiler-manufacturing industry in the near future.

Suggestions for Competitors for the $10,000 Lincoln Arc Welding Prize

The Lincoln Electric Co., donor of the $17,500 worth of prizes for the best paper on arc welding makes the following suggestions as to possible applications of welding which may assist in the production of papers of merit.

All applications of arc welding can be roughly divided into three classes: (1) Where welding replaces riveting. (2) Where welding replaces castings. (3) Where special designs possible with arc welding only will replace present-day designs at a saving either in cost of production or in resultant work.

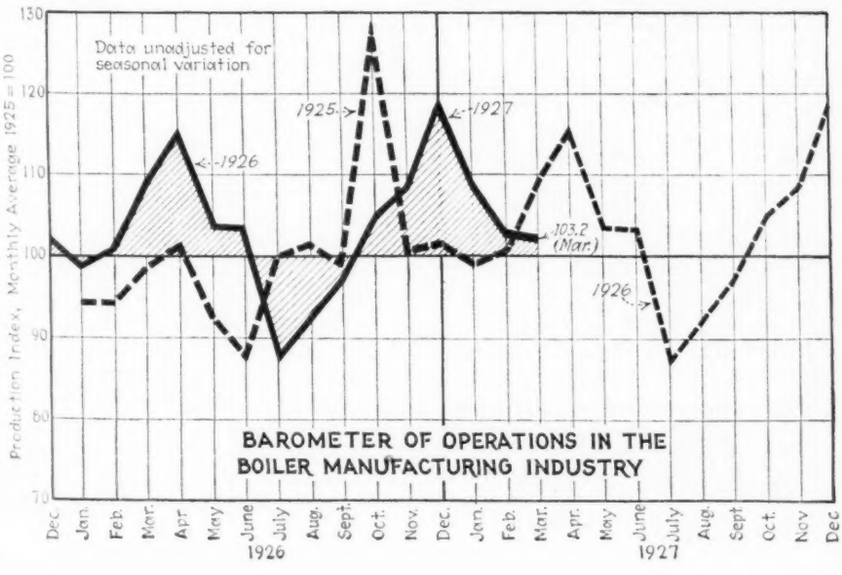
Taking these classifications in order, arc welding may be used instead of riveting on structures such as buildings, bridges, boats, boilers, tanks and pressure vessels. The problems here are the origination of designs which will use arc welding to the best advantage and the most economically, and also for methods whereby the erection of the parts may be done at the lowest possible cost. This is particularly true in the erection of fabricated steel in buildings, bridges and boats. A method of accomplishing this, which is commercially economical, would be of great value. Also, the fabrication of girders and columns so as to produce the maximum resistance to failure with the minimum cost, is something on which a tremendous amount of work can be done with profit.

Replacement and Building Up

The second classification is the replacement of cast structures which are now on the market with welded steel construction. The advantage of this is self-evident because of the greater strength, stiffness and lower cost of the steel compared with cast iron. It is suggested that Diesel engines, radiators, cast-iron pipe, boilers, all kinds of bases for machinery and like structures, can be replaced with enormous economies in first cost and frequently in operating cost by the substitution. The actual designing of this substitution, in all these cases is a problem of enormous importance. In this same line can be put machine tools of all kinds, automobile engines and the run-of-mine castings of the job foundry.

Under the third classification comes the large division of building-up operations, such as switch points, crossovers, railroad rails, oil stills, and all the many parts which from wear become obsolete or useless.

There are a number of other applications which perhaps do not come directly under the classifications mentioned, such as the manufacture of poles; towers from structural steel; the method of welded joint inspection so as to determine its strength without test; the making of field joints in pipe lines; the manufacture of agricultural machinery; the manufacture of rubber-tire molds from steel. Also, under this classification would come, lastly (what is perhaps the most important single thing in connection with this matter), devising methods for getting the facts regarding the advantages of arc welding into the minds of engineers and the general public so that its advantages will be understood and used.



Engineering Dean Condemns Overspecialization

That there is overspecialization in undergraduate engineering colleges, as evidenced in the growing number of degrees offered, is the contention of Charles H. Snow, dean of the School of Engineering of New York University, as expressed in his annual report to Chancellor Elmer Ellsworth Brown, made public April 12.

"The College of Engineering at New York University now gives no less than ten separate degrees. No sooner is instruction provided for some particular application of engineering than pressure is brought to bear for authority to give a degree acknowledging that application. This situation is not peculiar to our own institution, but exists in practically all schools of technology in the United States. It has no precedent in the older professions, nor is it entirely warranted in the engineering profession itself.

"The lack of system as to degrees in a profession which emphasizes the value of system can readily be explained. The practice of engineering is very old, but preparation for such practice in colleges is not. Engineering education is closely associated with the development of the United States, and with the evolution that has taken place in modern science. The schools of technology that have been created, here and there, have had to meet local conditions. No one of them was able to take the lead in a national sense."

A.S.T.M. Plans Thirtieth Annual Meeting

The thirtieth annual meeting of the American Society for Testing Materials will be held at French Lick Springs Hotel, French Lick, Ind., June 20 to 24. As the twenty-fifth anniversary of the incorporation of the society this meeting will have special interest for members. The Marburg lecture will again be featured and the Dudley medal awarded for the best paper of 1926.

Electrical Manufacturers Move Headquarters

The National Electrical Manufacturers Association has moved its headquarters office to the Graybar Building, 420 Lexington Ave., New York City, according to announcement by Alfred E. Waller, managing director.

The association has in its membership electrical manufacturing companies in more than 150 cities.

Permit of Roanoke Power Co. Is Extended

The Federal Power Commission has extended by one year the limitation date of the preliminary permit granted April 2, 1926 to the Roanoke Power Co. The permit covers a 50,000-hp. plant on Bugs Island near Clarksville on the Roanoke River in Virginia.

Personal Mention

W. H. Motz is now associated with S. C. Bloom & Co., refrigeration and air conditioning equipment engineers, contractors and manufacturers, 53 West Jackson St., Chicago, Ill., in the capacity of research engineer. Formerly Mr. Motz was technical engineer for the Hill Manufacturing Co., Chicago, Ill. He has contributed a number of articles to *Power*.

Society Affairs

A.S.M.E. Greenville Branch at Poinsett Hotel, Greenville, S. C., May 18, at 10 a.m., joint meeting with the Master Mechanics Division of the Southern Textile Association. Subject, Power Plant Operation.

A.S.M.E., Philadelphia, Engineers Club, 1317 Spruce St., April 26, at 7 p.m.; "Study on Surface Condensers in Steam Power Plants;" by J. A. Powell and H. J. Vottleson, both of the W. S. Barstow Management Association, Inc., of Reading, Pa.

Business Notes

The Kearfott Engineering Co., which was formerly at 95 Liberty St., New York City, is now in the new Roebling Building, 117 Liberty St., New York City.

The Magnolia Metal Co. has announced the removal of the head office and factory of the Canadian branch to 338-A St. James Street, Montreal, Quebec.

The McClave-Brooks Co. advises of the removal of its Chicago district office from Room 1510 Conway Bldg. to Room 1620 in the same building. Alfred Lotz is district manager.

The American District Steam Co. of North Tonawanda, N. Y., engineers of district steam heating installations and manufacturers of equipment for the underground distribution of steam have just distributed the first issue of their new house organ, the *ADSCO Advocate*. This new addition to literature on the broad subject of district heating will be devoted to the interest of all who are considering applications of underground steam or hot water distribution for heating and similar purposes.

The Philadelphia Electric Co., Philadelphia, Pa., for the installation of the first step of a large underground steam distribution system, which will serve sections of the business district of Philadelphia with district steam heating, has given a contract to the Northeastern Piping & Construction Corp., of North Tonawanda, N. Y.

Coming Conventions

American Association of Engineers. Annual convention, Tulsa, Okla., June 6-8; M. E. McIver, 63 East Adams St., Chicago.

American Boiler Manufacturers Association. Annual meeting at French Lick Springs Hotel, French Lick, Ind., May 30-June 1.

American Eletrochemical Society. Silver jubilee meeting at Philadelphia, Pa., April 27-30; H. E. Dalling, sec., Columbia University, New York.

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Bethlehem, Pa. regional meeting April 21-23, Pittsfield, Mass. regional meeting May 25-27. Summer convention at Detroit, Mich., June 20-24 inclusive; Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Order of Steam Engineers. Annual convention, Moose Hall, 1314 North Broad St., Philadelphia, Pa. June 13-16; J. E. Burke, 1821 So. Ringgold St., Philadelphia.

American Refractories Institute. Spring meeting at Hotel Traymore, Atlantic City, N. J., May 18-19; D. A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh, Pa.

American Society of Civil Engineers. George T. Seabury, secretary; Spring convention at Asheville, N. C., April 20-22. Annual convention at Denver, Col. July 13-15.

American Society of Mechanical Engineers. Spring meeting at White Sulphur Springs, W. Va., May 23-26. Calvin W. Rice, secretary.

American Society of Refrigerating Engineers. Western meeting at White Sulphur Springs, W. Va., May 23-25, in conjunction with the Spring meeting of the A.S.M.E.; W. H. Ross, 35 Warren St., N. Y.

American Society for Testing Materials. Annual convention at French Lick Springs Hotel, French Lick, Ind., June 20-24; J. K. Rittenhouse, secretary, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. W. M. Niesley, assistant secretary, 170 Broadway, N. Y. Annual convention Hotel Sherman, Chicago, June 6-11.

American Welding Society. Annual meeting at 29 West 39th St., New York City, April 27-28-29.

Association of Iron and Steel Electrical Engineers. Annual convention at Pittsburgh, Pa., June 13-18, inclusive.

National Association of Practical Refrigerating Engineers. Annual convention probably in November; E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27; John Topman, secretary, convention committee, Ohio State annual convention in Memorial Hall, Lima, Ohio, June 16-18; P. H. Grigsby, secretary, Lima, Ohio. New England States convention at Portland, Me., June 17-18; Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass. Indiana State convention and power show at Anderson, May 27-28. Plainfield, N. J., meeting at Academy Hall, June 3-5.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., June 8.

National District Heating Association. Annual convention at West Baden Springs Hotel, West Baden, Ind., May 17-20, inclusive; D. L. Saskill, secretary, Greenville, Ind.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Convention at Atlantic City, June 6-10; exhibition, June 4-10.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	April 4 1927
Pool 1	New York	$2.75@$3.25
Smokeless	Boston	1.66
Clearfield	Boston	1.65@ 2.00
Somerset	Boston	1.75@ 2.25
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.60@ 1.75
Pittsburgh	Pittsburgh	2.10@ 2.25
Pittsburgh gas slack	Pittsburgh	1.65@ 1.75
Franklin, Ill.	Chicago	2.50@ 2.75
Central, Ill.	Chicago	2.25@ 2.50
Ind. 4th Vein	Chicago	2.40@ 2.50
West Ky.	Louisville	1.50@ 1.75
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1	New York	2.50@ 3.00
Buckwheat No. 1	Philadelphia	2.50@ 3.00
Birdseye	New York	1.35@ 1.60

FUEL OIL

New York—April 14, light oil, tank-car lots; 28@34 deg. Baumé, 5⅜c. per gal.; 36@40 deg., 6c. per gal. f.o.b. Bayonne, N. J.

St. Louis—April 5, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.90 per bbl.; 26@28 deg., $1.95 per bbl.; 28@30 deg., $2.00 per bbl.; 30@32 deg., $2.05 per bbl.; 32@36 deg., gas oil, 4.6c. per gal.; 38@40 deg., 5.75c. per gal.

Pittsburgh—April 5, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6.5c. per gal.

Philadelphia—April 7, 27@30 deg., $2.31@$2.37 per bbl.; 13@19 deg., $1.89 @$1.95 per bbl.

Cincinnati—April 12, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—April 9, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.20 per bbl.; 26@30 deg., $1.25; 30@32 deg., $1.40.

Boston—April 12, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.45c. per gal.; 28@ 32 deg., 5.9c. per gal.

Dallas—April 9, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

The R. H. Beaumont Co. announces it has taken over the business of the American Manufacturing & Engineering Co. of Kalamazoo, Mich., and products formerly manufactured by this company.

The Northern Ohio Power & Light Co., serving Akron, Ohio, through its subsidiary, the Akron Steam Heat Co., has given a contract for the installation of a complete underground steam distribution system to the Northeastern Piping & Construction Corp., North Tonawanda, N. Y.

The Combustion Engineering Corp., Ladd Water Tube Boiler Co., and **Heine Boiler Co.** have consolidated their Cleveland district offices, which will be at 1107 Guardian Bldg., Cleveland, Ohio. Frank Henderson is Cleveland district manager of these three associated companies.

The Chicago Chemical Co., 6216 West 66th Place, Chicago, Ill., water service engineers and manufacturers, have finished the third addition to the plant which was built less than two years ago. This last addition doubles the size of the original plant which the company moved into June 28, 1925.

The Jenkins Bros. announce the appointment of Joseph E. Hodgkins, as manager, and Anthony D. Weber and assistant manager in charge of the company's New England branch, with headquarters at 524-530 Atlantic Ave., Boston, Mass. After almost forty years of service as manager with Jenkins Bros. and nearly 30 years as manager of the New England branch, John D. Stiles is now retiring from that capacity.

The Homestead Valve Manufacturing Co., Homestead, Pa., has secured the sole manufacturing and selling rights of the Homestead-Ross air valve, and in the future will market these valves through the company's agents and dealers throughout this country and Canada.

Trade Catalogs

Fuel Oil Burners—The Hardinge Brothers, Inc., 4149 Ravenswood Ave., Chicago, Ill., have issued an illustrated catalog showing typical installations of Hardinge fuel oil burners. A large sectional figure gives construction details.

Treating Feed Water in the Boiler—Increasing Efficiency of Lime and Soda Ash Softening Plants — The Chicago Chemical Co., 6216 West 66th Place, Chicago, has published two new bulletins, No. 9-A and 12-A. No. 9-A is an exposition of the company's "Flexible and Scientific Method of Treating Feed Water in the Boiler," issued under that title. No. 12-A deals with lime and soda-ash softening plants. Copies of these will be sent upon request to any engineer interested.

Stanwood Smokeless Boilers — The Stanwood Corp., Cincinnati, Ohio, has issued in Bulletin 500 a description of design and construction of its smokeless boilers specified for power and heating, built regularly for 15 lb., 100 lb., 125 lb. and 150 lb. working pressure.

Magnifying Manometers — The Bacharach Industrial Instrument Co., 7000-6 Bennett St., Homewood Station, Pittsburgh, Pa., in Bulletin 131, calls attention to a new development in the Bacharach magnifying manometer. This instrument uses two liquids of widely different specific gravities, oil and mercury, which results in a magnification of the readings as obtained in an ordinary mercury gage.

U-fin Generator Air Cooler — The Griscom-Russell Co. has just published a new bulletin, No. 1217, on the use of generator air coolers. This bulletin explains the application of generator air coolers, describes the special features of the U-fin cooler, includes a list of representative central stations and industrial plants equipped with this apparatus, and contains several illustrations of typical installations and arrangements. Free copies of this bulletin may be obtained by writing to the Griscom-Russell Co., 285 Madison Ave., New York City.

New Plant Construction

Calif., Los Angeles—Dohrmann Commercial Co., awarded contract for the construction of a 5 story addition to office and stores building at 789 South Flower St. to Scofield Engineering Construction Co., Pacific Finance Bldg. Estimated cost $1,000,000.

Calif., Los Angeles—Globe Investment Co., c/o Tierstein Construction Co., 1690 North Vine St., Contr., awarded contract for th construction of a 6 story apartment on Franklin Ave. Steam heating and electric refrigeration systems, elevators, etc. will be installed.

Calif., Sacramento—Owner, c/o G. C. Sellon & Co., State Life Bldg., Archts., awarded contract for the construction of a 16 story office building at 17th and J Sts. to Lindgren-Swinerton Inc., Standard Oil Bldg., San Francisco. Estimated cost $2,000,000. Four high speed elevators will be installed.

Calif., San Diego—San Diego Trust & Savings Bank, will soon award contract for the construction of a 13 story bank and office building including steam heating and ventilation systems, electric elevators, etc. at Sixth St. and Broadway.

Calif., San Francisco—Pacific Coast Amusement Co., Phelan Bldg., plans the construction of an ice skating rink at Civic Center Dist.

Calif., Visalia—Knudsen Laboratories Inc., 1965 Santee St., Los Angeles, is receiving bids for the construction of a creamery and power plant. Estimated cost $40,000. Train & Cressey, Western Mutual Bldg., Los Angeles, are architects.

Colo., Denver—E. F. Redding, Opera House Blk, Archt., will receive bids about Apr. 15 for the construction of an athletic building including boiler house, swimming pool, etc. at Speer Blvd. and West 7th Ave. for Jautzen-Denver Aquatic Athletic Corp., 406 Patterson Bldg., Estimated cost $300,000.

Conn., Fairfield—McKesson-Robbins Inc., c/o Fletcher-Thompson Inc., 542 Fairfield Ave., Bridgeport, Archt., awarded contract for the construction of a factory and boiler house here to T. J. Pardy Construction Co., 1481 Seaview Ave., Bridgeport.

Fla., Jacksonville—Jacksonville Ice & Cold Storage Co., awarded contract for the construction of an ice plant. C. H. Hornstein. Estimated cost $45,000.

Ga., Brunswick — Georgia Power Co., plans the construction of a steam power plant, also to rebuild distribution system. Estimated cost $200,000.

Ill., Chicago—Leander McCormick Estate, 332 South Michigan Ave., awarded contract for the construction of a 41 story apartment building at Lake Shore Drive and Delaware Pl. to Lundorff-Bicknell Co., 189 North Michigan Ave. Estimated cost $4,000,000.

Ill., Chicago—Saranac Building Corp., c/o Quinn & Christensen, 360 North Michigan Ave., Archts., awarded contract for masonry, etc. for a 9 story apartment at 5541 Everett Ave. Estimated cost $750,000. Central refrigeration plant, elevators, etc. will be installed.

Ill., Decatur—H. W. Metzler & Sons, Thatcher Court, awarded contract for the construction of a warehouse for wholesale produce including cooling rooms, refrigeration and dehumidifying machines, etc. at Cerro Gordo and Franklin Sts. Estimated cost $200,000. C. A. Moore, 901 South East 6th St., Minneapolis, Minn., is architect. Engineer not selected.

Ill., Springfield—City will soon award contract for the construction of addition to water, light and power plant on Sangamon River. Estimated cost $40,000. W. Seeley, City Hall, is engineer.

Ind., Howe — Howe Military School, awarded contract for the construction of a power plant to F. Herschberger, Middlesbury. Estimated cost $50,000.

Ky., Louisville—F. G. Breslin, c/o Breslin Sand Co., 32nd and Market Sts., awarded contract for the construction of a 17 story office building at Third St. and Broadway to Platoff & Bush, 122 West Liberty St. Estimated cost $1,500,000. Steam heating system, boilers, elevators, etc. will be installed.

Mass., Everett (Boston P. O.)—Beacon Oil Co., 30 Beacham St., is having preliminary plans prepared for the construction of a boiler house. Estimated cost $40,000. Private plans.

Mass., Gloucester—Bd. of Sewerage Survey, City Hall, will receive bids until Apr. 25 for the construction of a pumping station. Estimated cost $45,000. Fay, Spofford & Thorndike, 44 Bromfield St., are engineers.

Mass., Haverhill—Haverhill Electric Co., 121 Merrimack St., awarded contract for the construction of addition to switch house to H. G. Brown, 33 South Main St. Estimated cost $40,000.

Mass., Nantucket—Citizens Electric & Power Co., 56 Main St., awarded contract for the construction of addition to gas and electric plant at Grosby Pl. to T. R. Douglas, 22 Saben St., Providence, R. I.

Mass., Salem—Supt. of Public Buildings, City Hall, will soon award contract for the installation of a steam heating plant in fire station on Webb St.

Mich., Saginaw—City, S. W. Corrigan, Clk., will receive bids until May 24 for the construction of a pumping station including engine room, etc. H. H. Eymer, is engineer.

Miss., Howell—State Hospital Removal Improvement & Land Sale Comm., R. L. Brown, Secy., Capitol, Jackson, will soon award contract for the construction of two pump houses for State Insane Hospital here.

Mo., St. Louis—Evangelical Deaconess Home & Hospital, F. P. Jens, Supt., 4137 West Belle St., will receive bids about June 1 for the construction of a hospital including separate steam heating plant, etc. at Oakland St. and Clayton Rd. Estimated cost $800,000. T. P. Barnett Co., Arcade Bldg., is architect.

N. J., Elizabeth—Elizabeth Chamber of Commerce Hotel Co., 215 Broad St., will receive bids about Apr. 21 for the construction of a 10 story hotel including steam heating and ventilations systems, boilers, elevators, etc. on North Broad St. Estimated cost $450,000. W. L. Stoddart, 50 East 41st St., New York, N. Y., is architect and engineer.

N. J., Newark—John A. Roeblings Sons Co., 83 Liberty St., New York, N. Y., will build an office building. Estimated cost $500,000. Hoggsen Bros., 485 5th Ave., New York, N. Y., are architects and engineers. Work will be done by separate contracts. Steam heating system, boilers, etc., will be installed.

N. Mex., Magdelena—City will soon award contract for the construction of a complete waterworks and distribution system including pumping equipment, etc. Estimated cost $50,000. Weiland Engineering Co., 725 Thatcher Bldg., Pueblo, Colo., is engineer.

N. Y., New York—Co-Operative Construction Co., c/o Turner & Bowden, 15 East 40th St., Archts., will soon award contract for the construction of a 13 story apartment including steam heating system at 8-14 Mitchell Pl. Estimated cost $800,000.

N. Y., New York—One Thousand Seven Hundred Seventy Six Broadway Inc., J. E. Gilbert, Pres., 501 7th Ave., is having preliminary plans prepared for the construction of a 21 story office building at Broadway and 57th St. Estimated cost $1,000,000. J. E. Gilbert, 501 7th Ave., is architect.

N. Y., New York—Paramount Hotel Corp., 147 West 47th St., will build a 22 story hotel at 227-237 West 45th St. Estimated cost $2,000,000. G. & E. Blum, 415 Lexington Ave., are architects. Work will be done by separate contracts.

N. C., Belmont—Catholic Orphanage, awarded contract for the construction of two school buildings including power house to Southwestern Construction Co., Charlotte. Estimated cost $315,000.

O., Canton—Central Alloy Steel Corp., plans the construction of a mill, electrically operated. Estimated cost $850,000.

O., Columbus—Dept. of Public Welfare, Ninth and Oak Sts., awarded contract for the construction of a power house for Deaf and Dumb Institution on East Main St. to Middle States Construction Co., 524 East Hudson St. Estimated cost $32,790.

O., Willoughby—The Painesville & Willoughby Improvement Co., c/o Hamberg Bros., 2935 Woodhill Rd., Contrs., awarded contract for the construction of a 7 story office and stores building. Estimated cost $500,000. Steam heating system, boilers, pumps, elevators, etc. will be installed.

Okla., Canton—City is having preliminary plans prepared for extensions and improvements to electric light and power plant. Estimated cost $35,000. Machinery will be required.

Okla., Carter—City plans an election Apr. 10 to vote $30,000 bonds for the construction of a complete waterworks system including two deep well pumps and motors, etc. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Okla., Tulsa—Exchange Trust Co., c/o H. H. Rogers, 14 East 3rd St., is having plans prepared for the construction of a 24 story bank and office building including steam heating system on Boston St. Estimated cost $2,000,000. Wear & Alford, 1923 Calumet Ave., Chicago, Ill., are architects.

Pa., Arden (mail Arden Mines)—T. J. Underwood, County Controller, Court House, Washington, Pa., will receive bids until Apr. 20 for the construction of a boiler house including steam boiler, 4 electric motors, washing machine with motor and water softener, etc. for County Home here.

Pa., Philadelphia—Philadelphia Hardware Malleable Iron Co., 9th and Jefferson Sts., plans the construction of a warehouse and boiler house, etc. at State Rd. and Rahn St. Wm. Steele & Son, 15th and Cherry Sts., are engineers.

Tex., Del Rio—Texas Central Power Co., Frost National Bank Bldg., San Antonio, is having surveys made for the construction of a hydro-electric plant and dam on Devils River here, initial capacity 6,000 hp., also transmission line from plant to about 30 towns. Estimated cost $1,600,000. S. Young, c/o owner, is engineer.

Tex., Santa Anna—West Texas Utilities Co., E. Morley, Dist. Mgr., Ballinger, Tex., will build a 15 ton ice plant. here. Estimated cost including equipment $30,000.

Tex., San Marcos—Texas Power & Light Co., W. C. Merritt, plans the construction of an ice plant. Estimated cost $45,000. Private plans.

Wash., Milton—City plans an election Apr. 26 to vote $50,000 bonds for the construction of a water and light plant.

Wash., Seattle — City has been granted permit by the Federal Power Commission for a hydro-electric development at Diable Canyon and Ruby Creek on the Skagit River. Plans include the construction of dams at Ruby ripraps and Diable Canyon, also at intake of the present Gorge plant, power plants at Ruby ripraps and Diable Canyon and transmission lines connecting plants with existing $11,000,000 Gorge project.

Wis., Portage—Wisconsin Power & Light Co., 16 North Carroll St., Madison, plans the construction of a power plant here. Estimated cost $40,000. Engineer not selected.

Wis., West Allis—Le Roil Co., plans the construction of a receiving and shipping building, boiler room, etc. including boilers, etc. on 60th Ave. O. P. Williams, is engineer.

N. B., St. John—The Petitcictiac Jidal Power Co. Ltd., c/o A. P. Paterson, will soon receive bids for the construction of a 100,000 hp. hydro-electric development on the Petitcictiac River. Estimated cost approximately $10,000,000.

Ont., Sault Ste. Marie—C. E. Schley, 1121 Lafayette Bldg., Detroit, Mich., Archt., is preparing plans for the construction of a 14 story hotel including steam heating and ventilation systems, boilers, elevators, etc. here. Estimated cost $1,500,000. Owner's name withheld.

Ont., Toronto—Canadian Bank of Commerce, 21 King St. W., plans the construction of a bank and office building including steam heating system, elevators, etc. on King St. Estimated cost $3,000,000. Architect and engineer not selected.

Equipment Wanted

Air Compressors—Dept. of Welfare, J. E. Harper, Dir., Ninth and Oak Sts., Columbus, O., is in the market for two steam driven air compressors for Institution for Feeble Minded.

Boiler — L. & M. Brown Co. Ltd., 750 Carriere St., Montreal, Que., is in the market for a 10 hp. steam boiler.

Boiler — W. J. Moore, Auditor, Tulsa, Okla., is in the market for a 120 hp. water tube boiler for Mohawk pumping station.

Boiler, Motors, Etc. — T. J. Underwood, County Controller, Court House, Washington, Pa., will receive bids until Apr. 20 for steam boiler, 4 electric motors, etc. for County Home at Arden, Pa.

Electric Motors — Vogt Mfg. Corp., 408 St. Paul St., Rochester, N. Y., will be in the market for electric motors for proposed factory on Fernwood St. Estimated cost $275,000.

Engine—City of Elkhart, Ind., will receive bids about Apr. 17 for a turbine engine.

Engine — M. Judd & Son, Fellsway and Second Sts., Medford, Mass., is in the market for a 100 hp. steam engine.

Engine and Generating Set—C. M. Burdick, Medical Supt., Dannemora State Hospital, Dannemora, N. Y., will receive bids until May 2 for a 120 hp., 225 r.p.m. steam engine 170 lb. pressure at the throttle against back pressure of 5 lb. and 75 kw., 115 v., d.c. generating set.

Engine and Generator — Southwestern Power Co., C. Lamphere, Mgr., Alva, Okla., is in the market for a 480 hp. engine and generator for proposed addition to power plant.

Generator—Pacific Gas & Electric Co., 245 Market St., San Francisco, Calif., is receiving bids for a 40,000 hp. steam turbine generator for Station C, Oakland, Calif.

Generator and Condenser—City of Fremont, Neb., will receive bids until Apr. 20 for a 2,500 kv. turbine generator and condenser.

Generator Unit—City of Blair, Neb., will receive bids about May 1 for generator unit for proposed addition to power plant. Estimated cost $35,000.

Ice Machine—Newport Mill Co., Newport, Tenn., is in the market for a 20 to 25 ton ice machine.

Motor—Poyaners Ltd., 1416 St. Lawrence St., Montreal, Que., is in the market for a 7 hp. electric motor.

Pump—Dept. of Public Works, Eleventh Naval Dist., San Diego, Calif., plans the construction of a cooling tower, installation of a circulating pump, etc. in Naval Operating Base.

Pump and Motor — City of Medford, Okla., is in the market for a new 300 g.p.m. centrifugal pump and 15 hp. motor.

Pumps—Dept. of Public Works, A. A. Sprague, Comr., 406 City Hall, Chicago, Ill., will receive bids until Apr. 20 for two 40 g.p.m. motor driven centrifugal pumps with miscellaneous equipment for Western Avenue pumping station, 49th St. and Western Ave.

Transformers—City of Anderson, Ind., is in the market for transformers for proposed addition to electric light plant. Estimated cost $35,000.

Transformers, Switch Gear, Etc.—Bd. of Public Works, San Francisco, Calif., will receive bids until May 4 for transformers, switch gear and accessories for Coast Range tunnel power supply, Hetch Hetchy project. Estimated cost $80,000.

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